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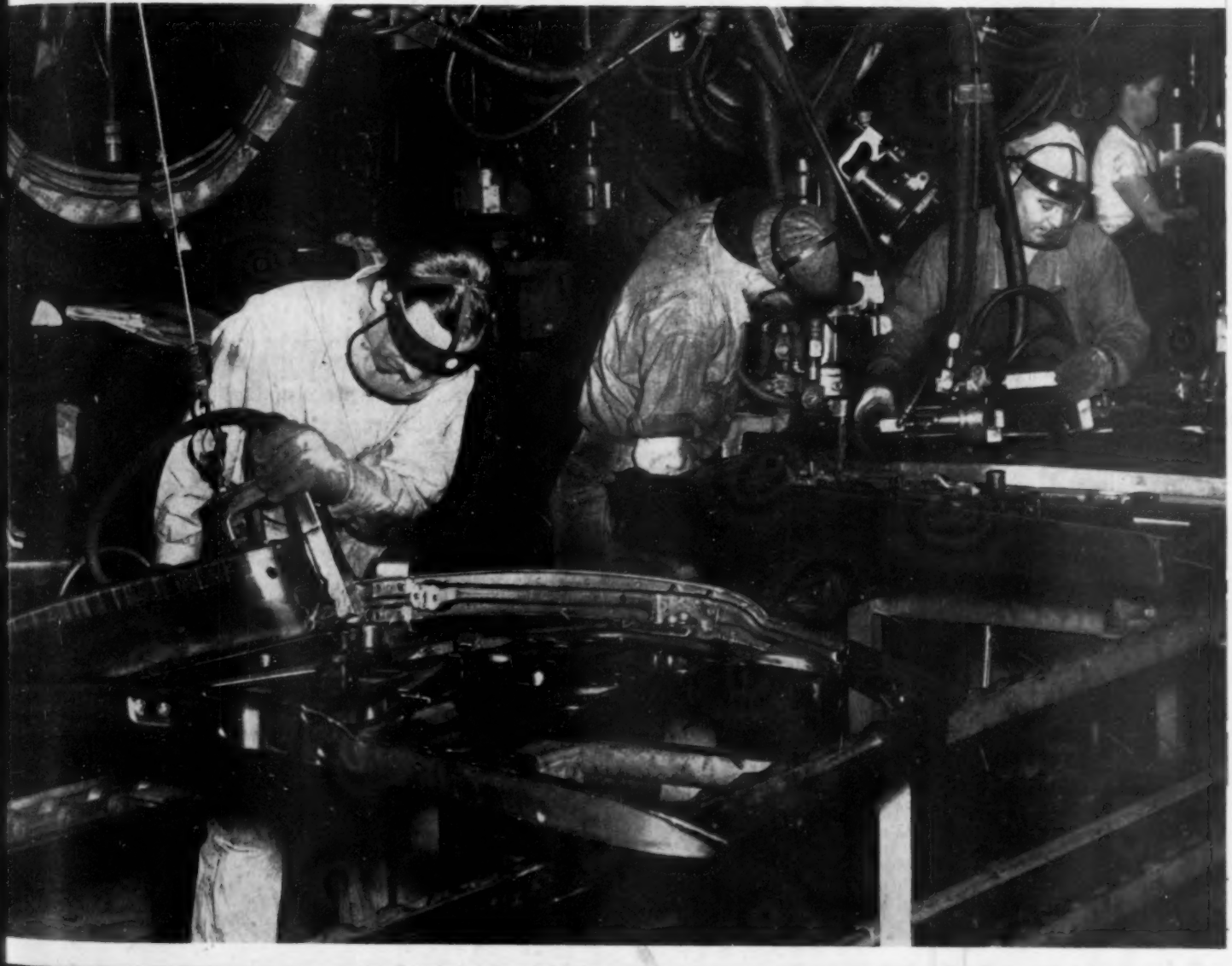

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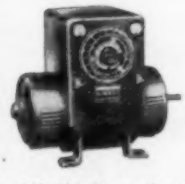

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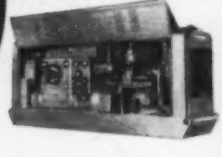

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APRIL 1948

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COVER

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The Manufacture and Application of Composite Plates*

By O. R. Carpenter†

The article describes the resistance seam welding method of producing stainless steel clad plate, the apparatus needed together with physical and metallurgical properties. Some applications are indicated.

THE successful manufacture of composite plates has been the object of many patents and patent applications for the past 20 to 25 years. A review of the patents issued in this field gives one a good indication of the many schemes which have been proposed. A knowledge of present-day methods indicates how few of these have had even moderate success.

It might be pointed out that a corrosion-resisting steel, such as the chromium-irons and the chromium-nickel-stainless steels, are so by virtue of a tight chromium oxide formation on their surface. This oxide is an extremely difficult one to remove by fluxes or other methods. A gas welder who has had some experience with the welding of this type material will verify the great difficulty encountered when trying to keep the molten puddle and the weld free of oxide. It is not as soluble in steel, as iron oxide, so that the freedom which a blacksmith experiences in joining two steels together is not possible with most chromium alloy steels.

The efforts of most composite plate makers have therefore been toward the discovery of a practical means of preventing the formation of oxides on alloy steels while these are being heated and joined, or bonded, to the surface of a carbon-steel slab or plate. The successful methods of today may be classified as: One, that of an assembly of the stainless and a steel slab into a sandwich with the stainless material protected on its bond side by plating with either nickel or iron. The heat and pressure of the subsequent rolling operation then forms the desired bond. Two, resistance-welding methods which attach to a steel plate, of the finish size and thickness, a number of alloy sheets by means of resistance spot or seam welding.

The first method has several variations. One successful procedure is to plate the cladding material with nickel or iron. This plated surface is placed in contact with the cleaned face of a steel slab and is secured there by welds and bars. Two similar assemblies are usually placed together with a parting compound between the outside faces of the clad surfaces so as to form a sandwich, and facilitate rolling. This sandwich is heated to 2200 to 2300° and rolled to the desired plate thickness. The rolling operation produces a bond which could be likened to recently described solid-phase welds. This bond, as long as oxides of chromium or others which are not soluble in the steel at rolling temperatures are absent, is strong and generally satisfactory for many applications.

Another variation of the slabbing method is one which produces a *fused* bond by the inter-melting of two or more metals against the face of a steel slab. The rolling of this composite slab by a mill produces a clad plate.

A new variation of the slabbing process which has just recently been developed by The Babcock & Wilcox Co. and which produces a fused bond will be described later in this paper.

The resistance-welding methods are generally familiar to most users of clad materials. Two variations of this method are used. One is the use of spot welds which are

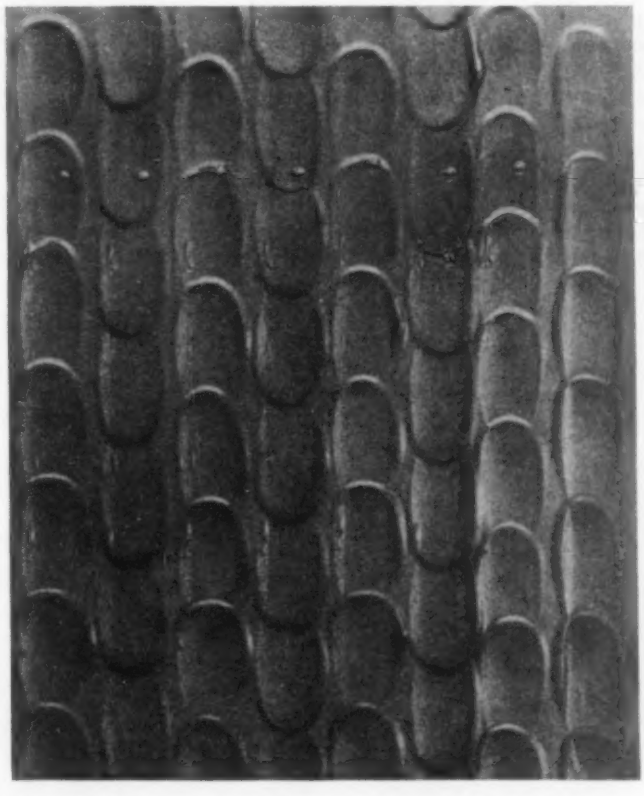


Fig. 1—View of Surface of Resistance Seam Welded Clad Plate

* Contributed by the Petroleum Committee, Process Industries Division for presentation at the Petroleum Conference in Houston, Tex., Oct. 5–8, 1947, of The American Society of Mechanical Engineers.

† The Babcock & Wilcox Co., Barberton, Ohio.

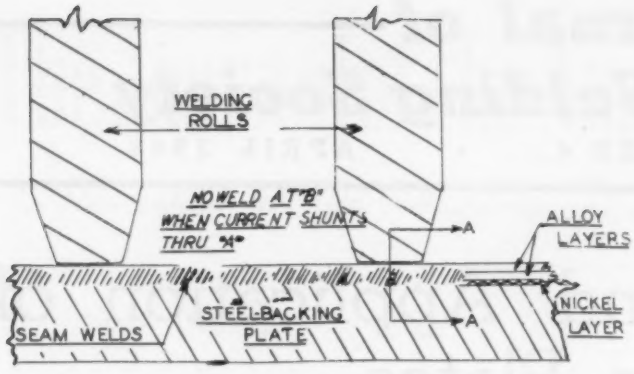


Fig. 2

made upon approximately 1-in. centers over the entire surface of alloy sheets assembled to a steel backing plate of the finish size. The second is the use of overlapping spot welds, commonly called seam welding, for attachment of alloy sheets to the finish size steel plate.

This latter method is that used by The Babcock & Wilcox Co. The use of overlapping welds gives an area of bond equal to approximately 75% or more of the total. Figure 1 is an unretouched photograph of the surface of this type weld. The spot welds overlap in the longitudinal direction of each seam. There is a slight separation of the fusion zones of adjacent seams or rows. Obtaining resistance welds on such close centers which are consistent in strength and penetration is rather an unusual problem in resistance welding. It may be of interest to discuss briefly the methods used to accomplish these results.

Seam-Welded Clad Plates

The use of spot welds on close centers and over an extended area makes the problem of shunt currents a difficult one. Shunt current in resistance welding is the bypassing of a part or all of the welding current through completed welds rather than through the contact surfaces at the point of electrode pressure. Where shunt currents are excessive, poor or interrupted welding is experienced, and over-heating of the electrode contact surface takes place. Figure 2 shows diagrammatically this condition. To overcome the effects of shunt currents, one may open the spacing between individual welds to an extent where the current path through the completed weld is a higher resistant one than that formed

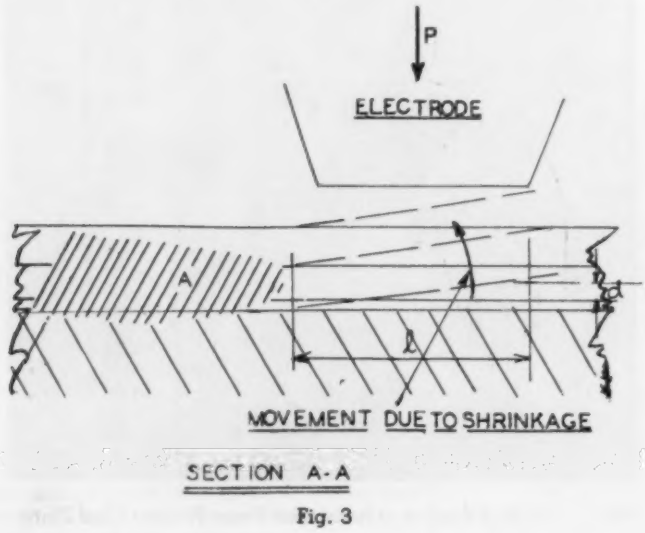


Fig. 3

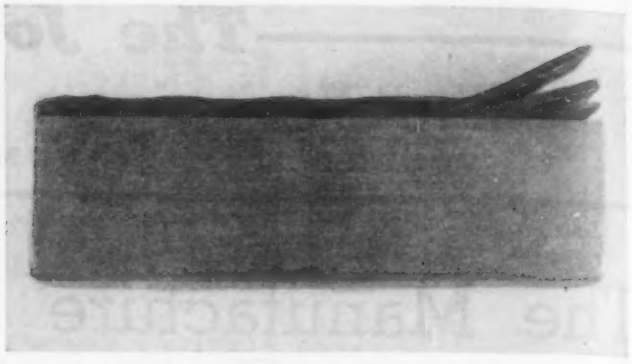


Fig. 4—Macro of Section of Clad Plate

under the electrode by the pressure and the contact of the clad material with the roll and the steel face. Or, if it is to be avoided on close center welds, such as shown by Fig. 1, the contact resistance between the roll and the alloy and the alloy and the steel must be reduced to a value low enough to give less voltage drop along this path than along that of the completed weld. To accomplish this, other than by wide spacing of the welds, the problem becomes one of obtaining adequate pressure under the electrode adjacent to the completed weld. Figure 3 illustrates the action of shrinkage stresses due to the completed weld *A* in raising the alloy clad layer away from the steel. When the distance between adjacent rows of welds or individual spot welds is small, the force required to replace the alloy in sufficient contact with the steel to overcome excessive shunt currents is great. The cladding layer might be considered as a beam supported at weld *A* (Fig. 3) and free on the other or opposite end. The force *P* required to deflect it then may be in proportion to the square of the alloy thickness. Therefore, an increase in the number of layers used to make up the alloy liner, as from one to two, will make the electrode pressure more effective in obtaining a low enough resistant path for the current to pass in this area in preference to the longer path through the finished weld.

The clad layer is usually made up of three layers consisting of two of the alloy material and one of pure nickel. This construction is shown in section by the macrograph of Fig. 4.

The layers are separated at the edge to show the relative thicknesses of each. This type cladding makes use of the nickel inner layer for two basic reasons. It is an aid to the prevention of carbon migration, which will be briefly discussed later in this paper. The nickel also aids materially in increasing the total area bonded to the steel. The flexibility of the clad layers allows the welding pressure to be transmitted to the surfaces to be joined beyond that area welded at fusion temperatures. Nickel

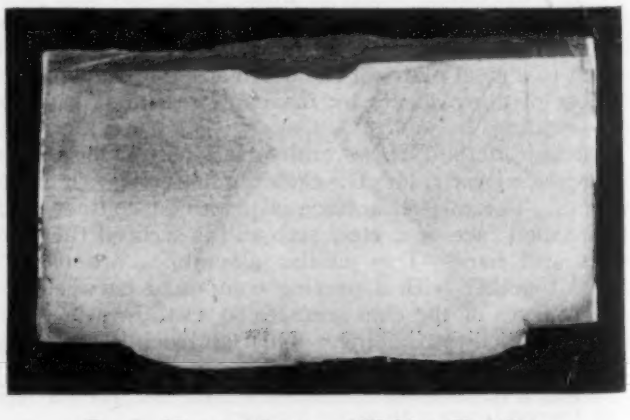


Fig. 5—Macro of Section of Weld in Clad Plate

will bond to steel at a relatively low temperature and it has been shown that, along the edges of the fused area of the resistance weld, a region of nickel is fully bonded to the steel and alloy. This region of "solid-phase" bonding has a tensile strength of 10,000 to 15,000 psi. It improves the heat transfer properties of the cladding and the general over-all efficiency of the liner.

Applications

Croloy Bonded plates may be formed and handled without many special precautions. Cold-working operations, such as rolling into shells, are performed in the same manner as for steel plates. Hot forming will depend upon the type of cladding and backing material. Such precautions as would be used for the liner material are used for the composite plate.

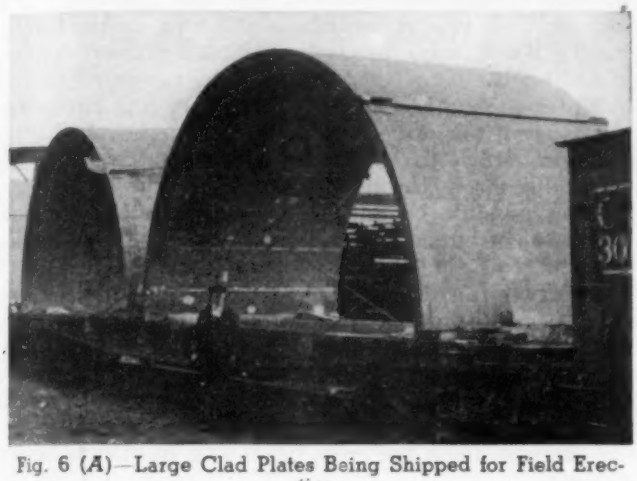


Fig. 6 (*A*)—Large Clad Plates Being Shipped for Field Erection

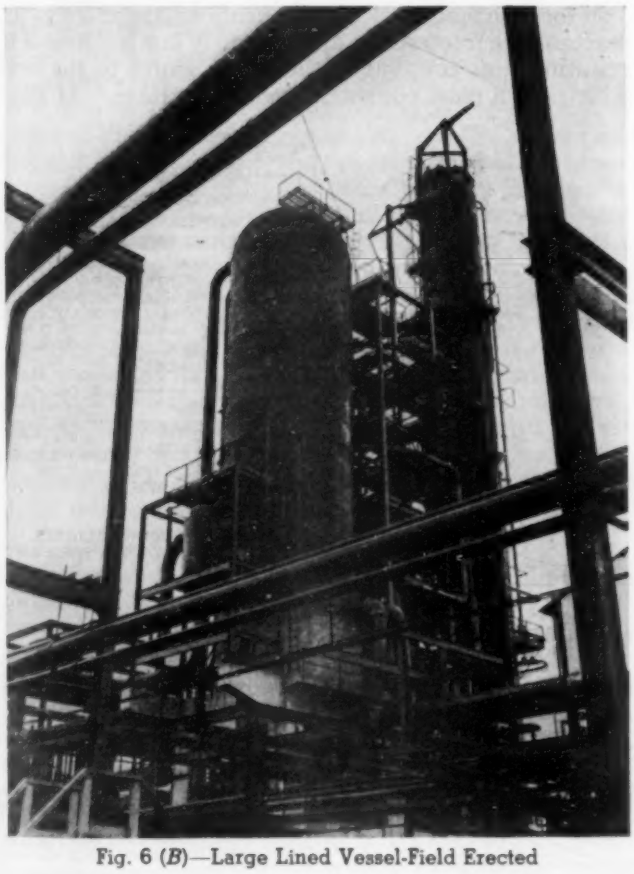


Fig. 6 (*B*)—Large Lined Vessel-Field Erected

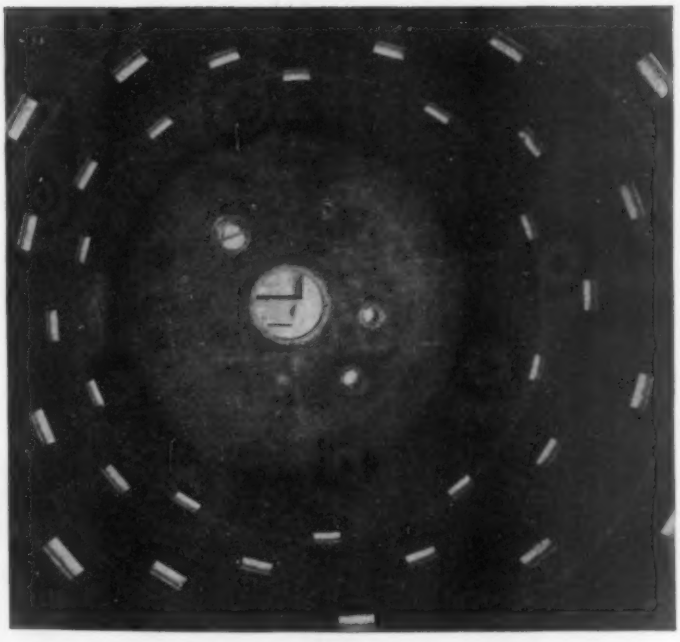


Fig. 6 (*C*)—Inside of Large Lined Vessel

Flame cutting may be accomplished almost as readily as for steel except that larger tips are usually employed. Welding follows usual practice for clad plates. Either a solid alloy weld or a filler strip may be used to close the alloy over the steel weld. The cladding is usually extended to the edge of the weld groove and planed or chipped back to avoid contamination of the steel weld. The cladding thickness is uniform so that cutting it back the desired amount presents no special problems. Etching of the cut-back edge is wise to be certain that all of the alloy material has been removed.

Figure 5 shows a macrograph of a section of a weld in a Croloy Bonded plate where the alloy closure has been made by arc welding.

Figure 6 (*A*) is a view showing fabricated plate sections of a large diameter tower which are being shipped to the field for erection. Figure 6 (*B*) shows this tower in the field following erection. It has a 20-ft. inside diam. and

Fig. 6 (*D*)—Clad Plate After Forming Large Head

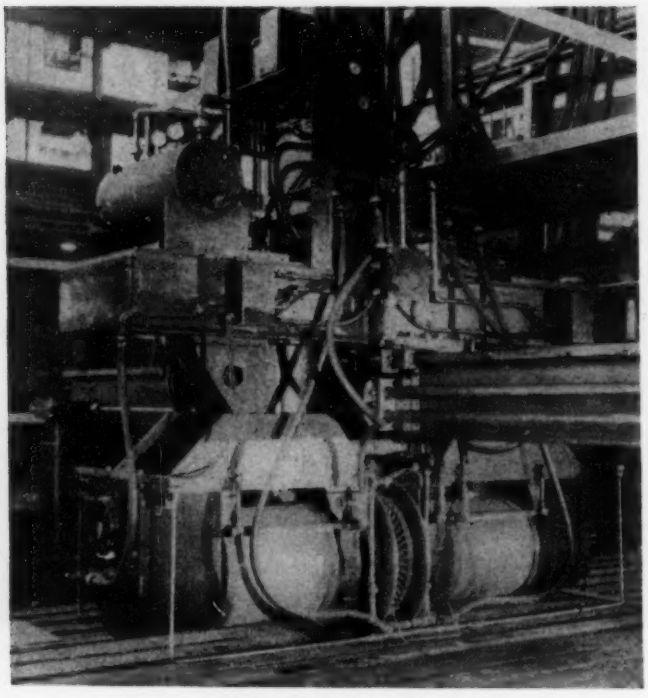


Fig. 7—View of Cladding Machine

has an over-all height of 100 ft. Its total weight is 150 tons. It is fully lined with 12.5 to 13.5% chromium liner, $^{5}/_{64}$ in. thick. The steel backing plate is A-70 steel, $^{3}/_{4}$ in. thick.

Figure 6 (*C*) shows the inside of a 10-ft. diam. clad vessel. Note the method of attaching clips directly to the liner.

Figure 6 (*D*) shows a 10-ft. diam. spun head, clad with alloy Type 410.

Transformer and Machine Design

The welding of the clad plates described has resulted in the design of what is believed to be an unusual welder of a type heretofore not used for seam welding applications. In designing this machine (Fig. 7) our previous experience indicated we would need considerable power and voltage for short periods of time. The usual resistance welder makes use of a stationary transformer from which large secondary busses lead and which carry 40,000 to 50,000 amp. or more, depending upon the kva. rating of the machine. Even with extreme care in design, these machines usually have large secondary reactance losses with corresponding low power factors. In applications such as the manufacture of clad plate, large current carrying bearings are needed to get adequate support and current capacity to the welding rolls. An integral-type transformer, of the type shown, places the rolls directly within the secondary current carrying members of the transformer and, therefore, gets to the work its full output with a minimum loss. It becomes possible to reduce the over-all kva. demand by approximately one-half and the efficiency and latitude of application becomes measurably greater.

Figure 8 shows a general schematic diagram of the machine. This design makes use of two rotary-type transformers in which the primaries are connected in parallel by means of slip rings and of secondaries which consist of a single turn about the primary, series connected as shown. The secondary then makes up each transformer case and has a current path such as is indicated by the arrows. The primary core is circular wound and is designed for operation at 80,000 lines per square inch. Space limitations made necessary a section proportion of the core of approximately 6 to 1. The high voltage winding is supported around the core. It consists of pancake coils of four turns each of square copper tubing. Each coil is series connected so that the primary consists of 144 turns.

Water cooling is used for the primary and enters and leaves the transformer in the manner indicated by the diagram. It is to be noted that the primary cooling water discharges through the center of the transformer making possible cooling of the inner secondary hub. The case, or outside secondary, is cooled by water discharged over the outside.

The two transformers are mounted by means of a main bearing and individual vertical slides. Pressure to the welding rolls is transmitted through this mounting by means of the pressure cylinders shown. The centers of the welding rolls may be adjusted by means of screws and cross slides. A variable speed drive moves the entire carriage along the cross beam at a fixed rate during welding.

The advantages derived from such a transformer design for resistance welding applications are many. The reactance characteristics are extremely low because of the resulting close coupling of the power source to the work. This gives a more consistent welding voltage. It allows

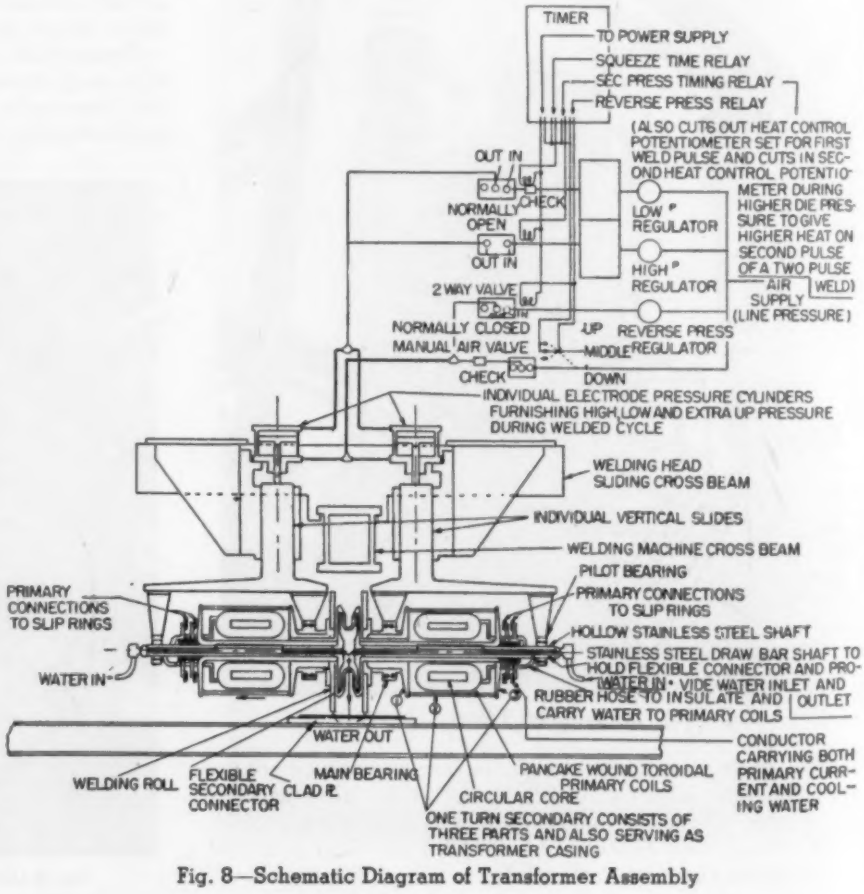

TIMER
TO POWER SUPPLY
SQUEEZE TIME RELAY
SEC PRESS TIMING RELAY
REVERSE PRESS RELAY
(ALSO CUTS OUT HEAT CONTROL POTENTIOMETER SET FOR FIRST WELD PULSE AND CUTS IN SECOND HEAT CONTROL POTENTIOMETER DURING HIGHER DIE PRESSURE TO GIVE HIGHER HEAT ON SECOND PULSE OF A TWO PULSE WELD)
OUT IN
CHECK
NORMALLY OPEN
OUT IN
LOW P REGULATOR
HIGH P REGULATOR
AIR SUPPLY (LINE PRESSURE)
2 WAY VALVE
NORMALLY CLOSED
MANUAL AIR VALVE
CHECK
UP
MIDDLE
DOWN
REVERSE PRESS REGULATOR
INDIVIDUAL ELECTRODE PRESSURE CYLINDERS FURNISHING HIGH, LOW AND EXTRA UP PRESSURE DURING WELDED CYCLE
WELDING HEAD SLIDING CROSS BEAM
INDIVIDUAL VERTICAL SLIDES
WELDING MACHINE CROSS BEAM
PILOT BEARING
PRIMARY CONNECTIONS TO SLIP RINGS
PRIMARY CONNECTIONS TO SLIP RINGS
HOLLOW STAINLESS STEEL SHAFT
STAINLESS STEEL DRAW BAR SHAFT TO HOLD FLEXIBLE CONNECTOR AND PROVIDE WATER INLET AND OUTLET
WATER IN
RUBBER HOSE TO INSULATE AND CARRY WATER TO PRIMARY COILS
WATER OUT
CONDUCTOR CARRYING BOTH PRIMARY CURRENT AND COOLING WATER
WELDING ROLL
FLEXIBLE SECONDARY CONNECTOR
CLAD
MAIN BEARING
CIRCULAR CORE
PANCAKE WOUND TOROIDAL PRIMARY COILS
ONE TURN SECONDARY CONSISTS OF THREE PARTS AND ALSO SERVING AS TRANSFORMER CASING

Fig. 8—Schematic Diagram of Transformer Assembly

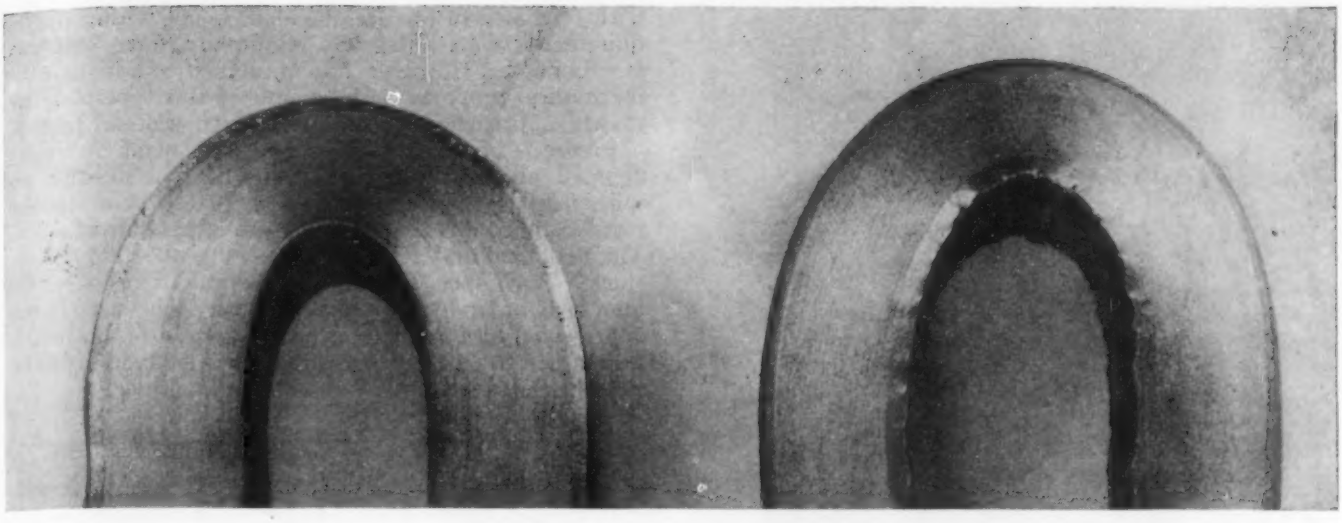


Fig. 9—Face and Reverse Bend Tests

for considerable power savings since an equivalent secondary current can be obtained from a design of half the normal kva. capacity. It allows for higher current flow into the work for shorter periods and helps, therefore, in overcoming shunt current troubles and contact resistance problems.

In order to obtain optimum welding conditions and the minimum contact resistance, a variable pressure and current application is used for each resistance weld. This system makes use of a pulsating current to the weld which is obtained by means of a pulsation timer. During the initial pulse the pressure is reduced to a minimum value at which surface contact resistance will not affect the surface of the alloy. After a short period of current flow and a one- to two-cycle cooling time, a second pulse of current at higher pressure is applied. During the second pulse the current density to the weld is also increased. This second current pulse and accompanying pressure increase gives greater depth of penetration, increases the area of the weld and allows higher currents for shorter periods, an important factor with some alloys.

Experience with a complicated seam welding set up, such as the one described, has shown that, where the welding rolls travel over a comparatively long distance, (10 ft.) stresses build up in the equipment and cause a variable pressure condition between the start and finish of a welded seam. To overcome this condition a reverse pressure is applied between each weld. This re-establishes original conditions and gives more consistent welds for the full length of the seam.

Mechanical Properties of Croloy Bonded Plates

The physical properties of and application of integrally clad plates has been covered by the A.S.M.E. Code by Cases 896 and 828, revised recently by the Special Committee on Clad Plates. These cases now specify under what circumstances the liner thickness may be used for vessel calculations, the requirements for welding and of meeting corrosion conditions at the weld, inspection of welds and material; emphasis is made of special requirements, where alloys of certain types are used. These cases also recognize "Applied Linings." Such linings are defined as those applied to the walls of vessels by any process or method that results in a material which does not meet the requirements of SA-263, SA-264 and SA-265. These requirements include a shear test of the liner which must have a minimum strength of 20,000 psi. when tested in the manner described by the specification. Applied linings may be attached by means of strip, plug, resistance or equivalent processes. The method used is to be qualified and all "applied" clad plates are to be tested by air at a pressure of approximately 80% of the design pressure.

The Croloy Clad liner method described above,

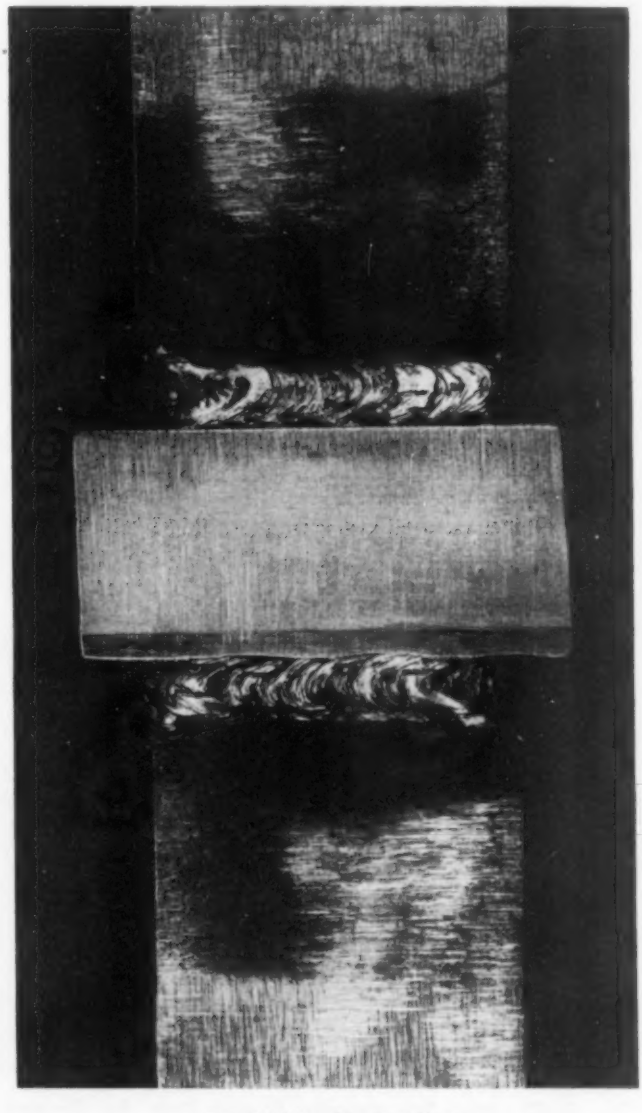
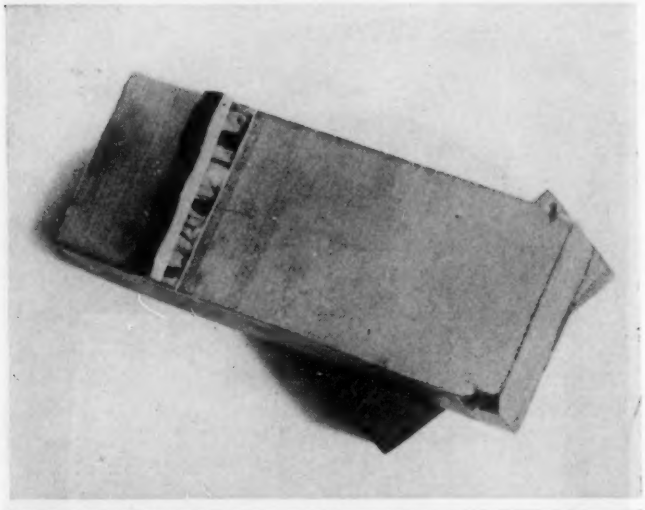


Fig. 10 (*A*)—Tension Test

Fig. 10 (*B*)—Tension Test



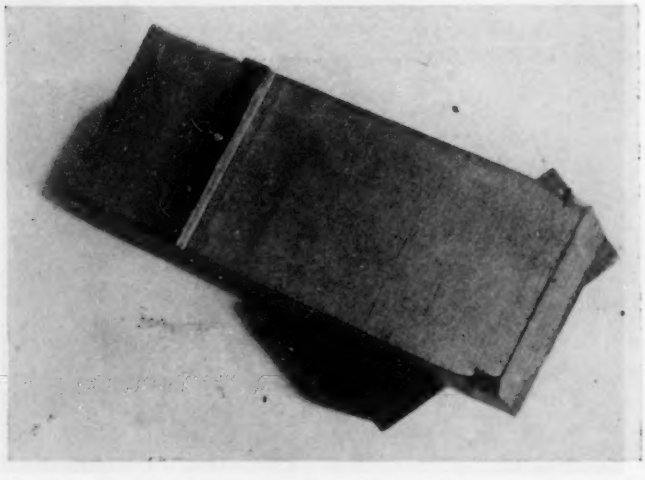


Fig. 10 (*C*)—Shear Test of Croloy Bonded Plate, Av. Strength 24,000 Psi.

with reference to the area bonded, is not within the requirements of an "integrally" clad plate, since some area is unbonded. However, it is of interest to note that the mechanical property requirements of this type plate are closely approached by this resistance welding process.

Figure 9 shows a face and a root bend of Croloy Bonded plate which meets fully the specification requirements. Figures 10 (*A*) and 10 (*B*) show tension tests made by welding steel bars to either side of a 2-in. square of clad material, clad with Type 405 alloy, $^{7}/_{64}$ in. thick. Such specimens fail at the line of fusion of the fillet weld on an average of 30,000 psi. This type of test is preferred to a shear test since it gives a better indication of the strength of attachment welds made to the inside liner surface of the vessel.

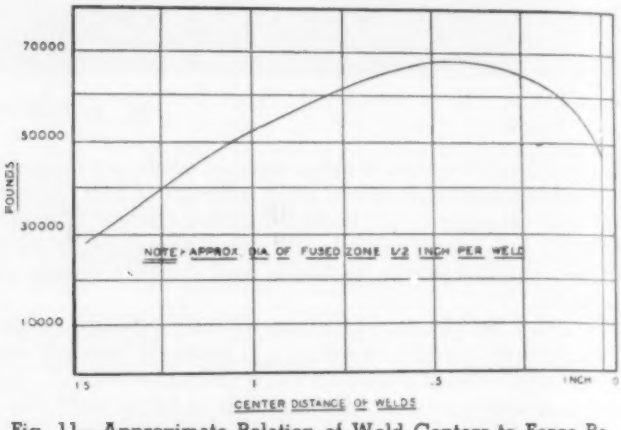


Fig. 11—Approximate Relation of Weld Centers to Force Required Pull Cladding from 2- x 2-In. Face

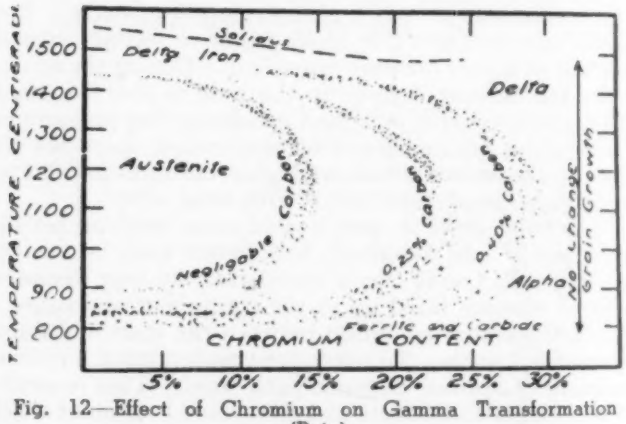


Fig. 12—Effect of Chromium on Gamma Transformation (Bain)

Figure 10 (*C*) shows a shear test of Croloy Bonded plate. It averages 24,000 psi. in shear.

Figure 11 is a curve which shows the effect of resistance weld spacing upon the tensile strength of the bond, determined with specimens such as shown by Fig. 10.

Metallurgical Considerations

The composition of the alloy liner to be used in clad vessel construction is dependent upon the requirements of the corrosive conditions involved in the service intended. The choice of alloys available may be grouped as (1) the simple, straight chromium transformable type (Type 410), (2) the ferritic chromium-irons which are nonhardenable and essentially of ferritic microstructure (Types 405 and 430), (3) the austenitic-nickel-chromium stainless steels (Types 316, 304, etc.) and (4) the nonferrous materials (nickels, Monel and Inconel).

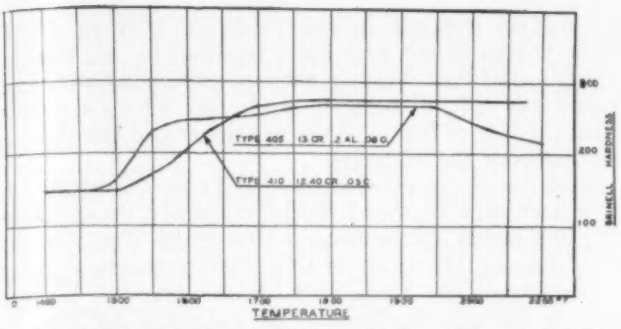


Fig. 13—Relative Hardening of Selected Type 405 and 410 Alloys

For many oil industry applications, a high chromium-iron of 11.50 to 13.50% chromium has given very satisfactory service. This steel is available as two types having slightly different properties. One (Type 410) is a transformable alloy which, when cooled rapidly from above its critical range, may form a hard martensitic structure and is therefore frequently referred to as a martensitic steel. This property may be objectionable for some applications because of the difficulties encountered in welding. Consideration of the so-called "gamma loop," Fig. 12, indicates that, by a careful selection of this material, an excessive "as-welded" hardness may be avoided. (See Fig. 13.) For, if the carbon and the

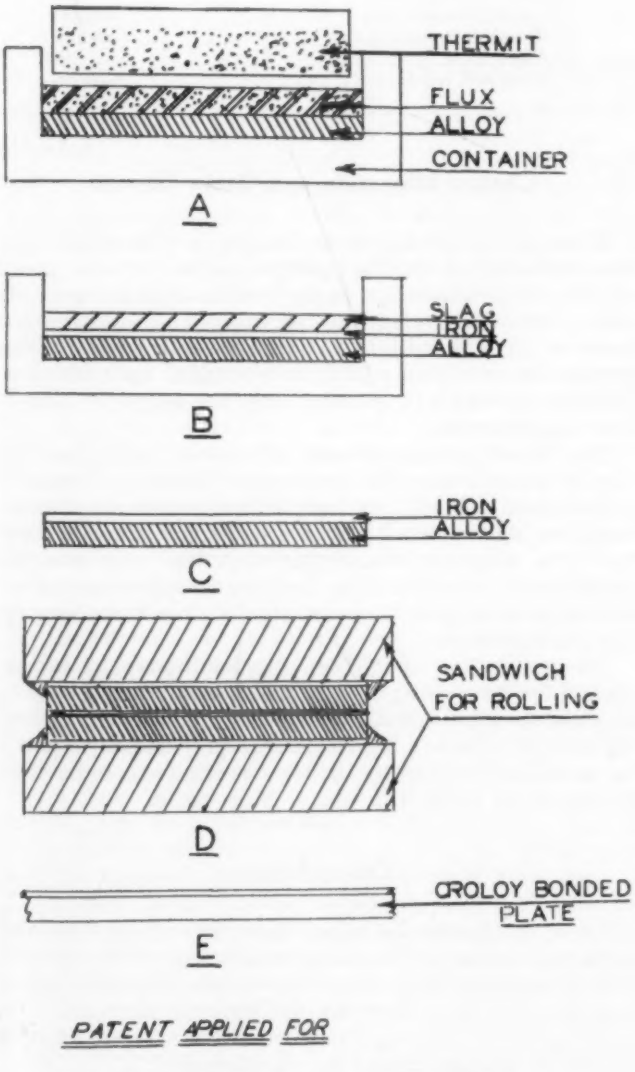


Fig. 14—Thermit Fused Clad Plate Method

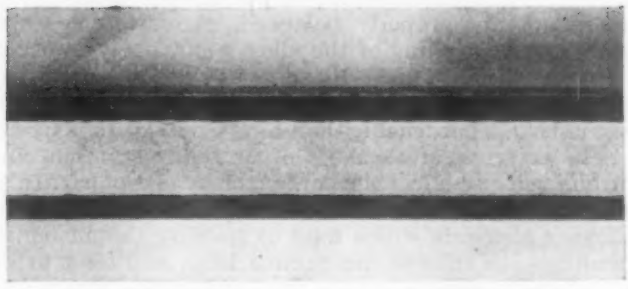


Fig. 15 (*A*)—Showing Section of Double Clad Plate

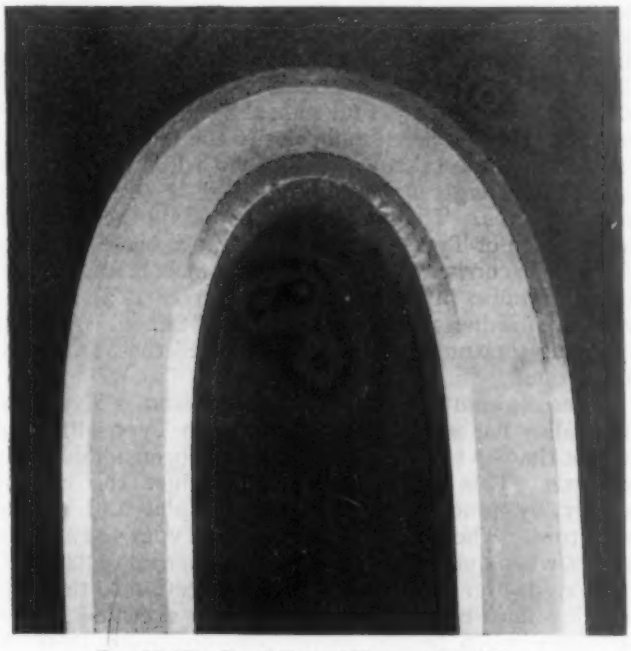


Fig. 15 (*B*)—Bend Test of Thermit Clad Plate

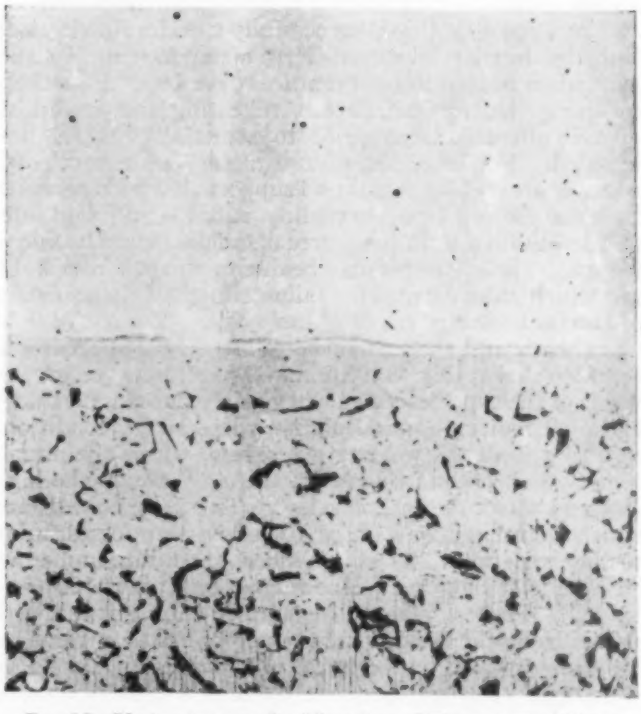


Fig. 16—Photomicrograph of Junction of Thermit Clad Plate (100 ×)

chromium are properly balanced, excessive hardening with normal working of the alloy is not likely to occur. For example, a Type 410 alloy having an analysis of 13% Cr – 0.05 to 0.08% C or 14% Cr – 0.08 to 0.09% C would be lass hardenable than 13% Cr and 0.15% C, etc.

The presence of elements other than chromium and carbon will also affect the hardenability of any particular iron-chromium-carbon alloy steel. Additions of the alloying elements which tend to stabilize the austenitic condition, or enlarge the gamma loop, will tend to increase the hardenability of a steel which otherwise would not excessively harden. For example, a 2% nickel addition to the balanced compositions of the preceding paragraph would result in greater hardening tendency.

Experience indicates that Type 410 alloy can best be resistance welded by the process described in this paper when the analysis of the clad material is held within the limits suggested above and which, when quenched from 1800° F., will show a maximum hardness of approximately 275 Brinell. Full annealing after the cladding operation is completed and prior to the vessel fabrication is usually undertaken, although with low carbons adequate softening can be accomplished at stress-relieving temperatures. This may be illustrated by the successful application of Type 410 arc weld deposits in clad plates. By using a core wire of 0.03 to 0.04% carbon, and holding the chromium in the deposit of 11.5 to 12%, an "as-welded" hardness of 250 Brinell was obtained. A stress-relieving treatment of 1150° F. reduced the hardness to 160 Brinell.

A second commonly used chromium-iron is Type 405. This alloy has a composition similar to Type 410 alloys except that up to 0.30% aluminum has been added to the analysis. This addition tends to reduce the hardenability by producing a two-phase alpha and gamma structure. The relative hardening of Types 410 and 405 alloys, when quenched from temperatures up to 2200° F., is given in Fig. 13. The principal objection to this type of alloy may be its tendency to form a coarse-grained structure when heated to temperatures over 1800° F. with a resultant cleavage brittleness. If the alloy is tempered after heating or welding in the range of 1200 to 1400° F., ductility is restored, however, in spite of its coarse grain.

The Type 405 alloy is successfully used for lined vessels but, due to its tendency to form a coarse-grained structure when heated to temperatures over 1800° F. and the resulting cleavage brittleness, reheating and reworking of the affected areas prior to stress-relieving is best avoided. For example, failure along the heat-affected zones of arc-welded seams and supports has been reported by some users. Upon rewelding, it has been found difficult to obtain a tight joint, free of cracks along the line of fusion. These failures may be due to stresses from welding which cause successive failures in the brittle regions of the heat-affected zones of the welds. The use of light weld beads and the avoidance of large welded areas will tend to help this condition. Overlapping resistance welds of the type described will give similar trouble under certain conditions, particularly where stress conditions resulting from the welding are severe, where the aluminum and chromium content of the alloy are on the high side and where the carbon is low. Two large coke drums which were lined with Type 405 alloy were found, upon testing with oil at 300 psi. pressure, to contain numerous cracks in the liner at regions where the seam welds overlapped. These cracks were examined carefully and were shown to be the result of reworking of brittle regions by the pressure and temperature of the resistance welding operation. The brittleness of the liner was attributed to a chromium content in excess of 13%, to an aluminum content near the allowed 0.30% maximum combined with low carbon content in the range of 0.04 to 0.06%. These cracks in the liner were repaired by arc welding. It was found that welding without producing additional cracks was difficult because of stresses set up at regions along the line of fusion of the arc welds and the cleavage brittleness of the material.

Since the above experience with Type 405 material we have been able to avoid similar difficulty by specifying 13% chromium maximum and aiming the other elements to so balance the analysis that there remains a correct proportion of the alpha and gamma phases. Such an alloy is slightly hardenable as indicated by Fig. 13. However, it is less brittle and more applicable to most conditions encountered in fabrication.

Table 1—Chemical and Physical Properties of Croloy Bonded Plate Slab Method

Chemical Composition	Face	Core	Face
Carbon	0.050	0.13	0.050
Manganese	0.67	0.57	0.67
Phosphorus	...	0.013	....
Sulphur	...	0.025	....
Silicon	0.52	0.085	0.49
Chromium	18.29	...	18.37
Nickel	9.20	...	9.22
Bond Shear Tests		62,000 psi.	
Alloy thickness		19.9 to 22.2%	
Total plate thickness		3/4 in.	
Physical Properties			
Yield strength, psi.		45,280	
Tensile strength, psi.		78,730	
Elongation % in 2 in.		38	
Rockwell hardness		B-84-86	

Carbon Migration and Grain Growth

When a composite plate having a chromium alloy liner is heated at elevated temperatures for some period of time, decarburization of the carbon steel immediately under the alloy cladding occurs. The decarburized layer of steel is subject to grain growth of the ferrite grains, the extent of which is dependent upon the temperature to which it is heated and the length of time at that temperature.

The practical importance of carbon migration will largely depend upon the temperature history of the composite plate. If relative high temperatures are encountered for short periods, as in welding, it is not believed that the resulting decarburization has any practical significance. As operating temperatures become higher, and after long periods, some significance may be given this phenomenon.

The prevention of carbon migration may be accomplished by interposing between the alloy and steel backing material a relatively thin layer of a material without affinity for carbon. This is successfully accomplished in the process described by the use of nickel sheets having a thickness of 0.007 in.

Other Alloys

There are numerous other materials which are often requested for use as liners for vessels but which, because of their unusual properties, do not lend themselves adequately to bonding by resistance welding methods. One such material would be Hasteloy; other materials having similar properties might be mentioned.

We have recently developed a new method for pro-

ducing composite clad slabs for subsequent rolling into plates which may be of interest. This method is believed applicable to most all alloys and nonferrous materials. It gives a fully fused bond of the clad material but does not have the objection of other similar fusion processes, which is an unevenness of the clad layer.

Figure 14 shows the various steps of this method in forming a slab for rolling into a clad plate. A plate of the desired alloy for the cladding is heated in a furnace under a flux. Following heating, the plate is withdrawn and, while at temperature, a box of thermit powder is positioned over it. The thermit powder is ignited, forming iron and slag which melts the box and deposits the iron slowly through the flux upon the surface of the alloy plate. In traveling through the flux, the thermit metal is cleaned or washed of slag and at the same time, by adjustment of the preheat and depth of the flux, its temperature is so regulated that fusion of the iron to the alloy occurs evenly over the entire face.

When iron has been deposited on the stainless or alloy plates, these are assembled with the steel slabs in contact with the iron face in a pack form, as indicated in Fig. 14, heated to the proper temperature and rolled by a mill. The rolling operation welds the steel slab to the iron surface which has previously been fused by thermit to the alloy material.

Various types of thermit powders may be used as suits the requirements. For example, nickel or stainless thermits may be employed. Thermit has the advantage of producing finely divided iron particles, superheated to approximately 5000°. These settle slowly through the flux and produce an evenly fused layer on the stainless plate.

Table 1 shows the physical properties of a double stainless clad plate produced in this manner.

Figure 15 (*A*) is a macrograph (actual size) of the bonded area. Also shown in Fig. 15 (*B*) is a bend test specimen of a $^3/_4$-in. thick double clad plate. Figure 16 is a micrograph at 100 diam. of the bond between the steel and alloy.

The Comparative Performance of Air-Supplied Welding Helmets

By Merril Eisenbud* and Leslie Silverman†

THE hygienic significance of the fumes and gases which occur in electric arc and gas welding, has been reported by several investigators, and protection for the welder is necessary under certain conditions. These include welding on galvanized materials, which produces a severe exposure to the fumes of zinc oxide, and the "torch cutting" or arc welding of steel which has been previously coated with lead paints.

Because of inherent limitations under many of the conditions encountered in industry, it is frequently difficult to provide suitable ventilation for protection of the welder. General ventilation, where possible, can provide adequate control over atmospheric contamination in the vicinity of the welder, but the proximity of his breathing zone to the source of fumes may prevent him from being benefited by this type of ventilation.

It is sometimes feasible to use local exhaust ventilation to capture the fumes at the arc, but the need for long flexible exhaust ducts also imposes a definite limitation on this type of protection.

There are certain welding operations where local or general exhaust ventilation is either inadequate, impractical or unnecessary to control the exposure in the operator's breathing zone. Air-supplied respirators, and metal fume filter type respirators are known to offer satisfactory protection against welding fumes, but the discomfort of wearing a respirator under the welding helmet has created considerable resistance to their use.

Another method of providing respiratory protection for the welder is the use of air-supplied helmets. In these devices, filtered air from a compressed source discharges into the helmet, flushing the wearer's face with fresh air and, to various degrees, preventing inhalation of the welding fume. This investigation was undertaken to determine the operating characteristics of the various types of air-supplied helmets that are now available.

Fig. 1—Plenum Air-Supplied Welding Helmet. Plenum Section Is Located in the Lower Part of the Helmet Just Below the Eye Shield

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Types of Air-Supplied Welding Helmets

There are at present three methods of introducing a supply of fresh air directly to a welding helmet, without the use of a conventional supplied-air respirator. The first such device to appear consists of a perforated metal tube that is mounted on the headband of the welding helmet. Air is supplied to this tube by a connecting rubber hose, and discharges through the perforations, in that manner supplying fresh air to the wearer.

In 1943, Krasno, *et al.*,[1] described a modification of this method in which a perforated tube is bent into a rectangular form which surrounds the glass window of the helmet. The perforations are arranged in such a manner as to discharge the air "away from the glass window and parallel to all surfaces of the hood." By controlling the airflow in this manner, the authors claimed to provide the wearer with positive protection against the welding fumes. This device is available commercially.

A third method of supplying air was described by Eisenbud[2] in 1945. Illustrated in Fig. 1, this design embodies a plenum which is created by mounting a suitably formed fiber sheet on a helmet of conventional design. Several square inches of the inner surface of the plenum are perforated, and fresh air which has been delivered to the plenum by means of a flexible connection is discharged through the perforations. It was claimed that by discharging the air from the relatively large total area of the numerous perforations, the supply of air to the breathing zone can be accomplished with a low entrance velocity, thereby minimizing turbulent flow within the helmet, and avoiding much of the difficulty in preventing the supplied air from being contaminated before it reaches the nose and mouth.

Method of Determining Protective Efficiency

The following test was devised in order to measure the breathing zone contamination by welding fume. Electric arc welding was performed on steel with $^5/_{32}$-in. coated rod. A triangular frame was cut from a respirator face-piece, and three $^1/_4$-in. rubber tubes mounted to it in such a manner that when the frame was worn by the welder, the tubes terminated under each nostril and in front of the mouth (Fig. 2). By extending these tubes to the rear of the welder's head, breathing zone samples could be conveniently obtained with the welding fume sampler which has been previously described by Silverman and Ege.[3] In this method the sample of air to be tested is drawn through filter paper by means of a hand pump and the iron oxide of welding fume produces a red-brown stain which can be rapidly quantitated by comparison with standards.

Welding was performed continuously, in a 1000-cubic foot chamber, throughout the period of test. Tests for breathing zone concentrations of fume were alternated with tests for the level of contamination outside of the helmet. For each set of conditions, samples were collected from each of the tubes described above, and from three positions outside of the helmet. The latter positions were located within 3 in. of the helmet, on the right, the left and in the front. For each set of conditions, the three breathing zone samples were averaged, as were the tests for ambient contamination.

Normal Concentration of Fume Within the Helmet

A group of samples collected alternately outside and inside of the helmets, when no fresh air was being supplied, revealed that under normal welding conditions,

Fig. 2—Location of Sampling Tubes for Determining Fume Concentrations Inside the Helmet. *A*, *B* and *C* are Rubber Tubes Which Are Connected to the Welding Fume Sampler

the concentration of fume within the helmet is approximately 60% of the fume concentration of the ambient atmosphere. This observation can be explained by the fact that the atmosphere within the helmet contains a substantial component of air which has been inhaled and exhaled by the welder. The reduction in fume content of this air results from retention of fume by the respiratory system. A summary of test data giving the comparison between breathing zone and ambient samples, with no air being delivered to the helmets, is given in Table 1.

Table 1—Comparison of Breathing Zone and Ambient Concentrations of Welding Fume (No Air Being Supplied to Helmets)

	No. of Tests	Av. Concn.*	Range*
Outside helmet	12	96	45–180
Inside helmet	11	58	37–150

* Milligrams of fume per cubic meter of air.

In expressing the protective efficiency of the air-supplied helmets being tested, we originally planned to calculate the efficiency on the basis of comparisons between the breathing zone and ambient concentrations, thus:

$$\text{Eff.} = (C_a - C_b)100/C_a \qquad (1)$$

where

C_a = concentration in ambient atmosphere
C_b = concentration in breathing zone

Because of the substantial normal decrease in the breathing zone concentration there would be a fallacy in this method of computing the efficiency, as can be seen from the fact that use of this formula *with no air supply to the helmet*, gives an efficiency of 40% instead of zero. To correct for the normal difference between the ambient concentration, and the concentration within the helmet with no fresh air supply, the basis for computing the efficiency was modified as follows:

$$\text{Eff.} = (0.6C_a - C_b)\ 100/0.6C_a \qquad (2)$$

Comparison of Protective Effectiveness

The ambient concentrations of welding fume were high during these tests, imposing rigorous conditions for determining the effectiveness of the air supply against contamination of the breathing zone. The data summarized in Table 2 show that air flows of 4 to 6 cfm. in the plenum type of air supply offers a protective efficiency of over 99%. The headgear tube has an efficiency of 50% which remained constant for the two rates of flow studied. The device described by Krasno, *et al.*,[1] revealed an efficiency of 73% at a flow of 4 cfm. which was somewhat higher than the efficiency found at flows of 6–8 cfm. which is the rate recommended by the manufacturer of this device. Apparently there is a critical velocity, above which entrained contaminated air enters the breathing zone.

Relationship Between Pressure and Flow

The pressure-flow characteristics of the various types of air supplies were determined because it was felt that such data are a definite feature of performance for any respiratory protective device. Furthermore, having established the relationships for pressure, and volume of air supply, the former could be used conveniently as a means for determining the flow in actual welding tests.

The volume of air being supplied by the helmets was measured directly by placing the helmets inside a large chamber and metering the discharge air with a rotameter. The pressure was measured with a mercury manometer at the helmet inlet tubes of the var ous air supply devices. The data obtained are given in Table 2, which shows that the phenum type of supply is able to deliver its rated volume of 4 cfm. at an inlet pressure of 0.65 psi, as compared to the Krasno design which requires from 4 to 7.3 psi. in order to deliver from 6 to 8 cfm., the recommended range of air flow. The head-band type operates at the highest pressure of the three designs, requiring 10.5 psi. at a flow of 6 cfm.

Measurement of Noise Level

The supply of air into a welding helmet is accompanied by more or less noise, depending on the manner in which the air is introduced to the helmet. The noise level for the three helmet designs, for various rates of flow, was measured with a General Electric Co. noise meter, and the findings are given in Table 2. The data are given in decibels, and also in "loudness units" according to the scale originally proposed by Fletcher and Munson[4] and adopted by the American Standards Association.[5] It is apparent that for all three methods of air supply, the noise level increases markedly with increases in the volume of air being delivered. The plenum type of supply admits air to the helmet at considerably lower velocity than the other designs, thus accounting for its somewhat lower noise level.

Noise levels were recorded by placing the instrument pickup at the ear of the wearer with the helmet being worn in the normal manner. The decibel readings for the head-band and the Krasno type were considerably higher than those obtained on the plenum type, an observation which can be explained by the higher air velocities employed in the former. According to McCoy[6] noise levels of 80 to 85 decibels may possibly cause hearing defects after a period of years. The plenum helmet, when operated at 4 cfm., reaches a noise level of 74 decibels which is well within the satisfactory range.

Table 2—Summary of Performance Characteristics of Air-Supplied Helmets

Air Flow, Cfm.	Av. Concentrations, Mg. per Cu. M. Ambient	Av. Concentrations, Mg. per Cu. M. Breathing Zone	Protective Efficiency, %	Pressure at Helmet Air Connection, Psi.	Noise, Decibels	Loudness Units
			Head Band			
2	...	..	..	0.75	79	15,800
4	130	39	50	5.0	89	35,000
6	130	38	50	10.5	92	45,000
			Krasno, *Et al.* 1			
4	135	22	73	2.2	81	18,400
6	118	25	65	4.0	86	27,200
8	60	28	22	7.3	92	45,000
			Plenum			
1	230	32	78	0.03	62	4,950
2	100	4	93	0.10	69	7,440
4	290	1	99+	0.65	74	10,600
6	80	..	99+	2.0	82	19,800
8	80	1	98			

Summary

The performance characteristics of three types of supplied air welding helmets were studied. The plenum method of supplying air provided a protective efficiency of over 99% as compared to a maximum of 73% for the next best design. The plenum helmet was likewise more satisfactory because of lower operating pressure and less noise. Supplied air helmets of proper design offer a high degree of protection against welding fumes. In addition to the protection afforded the cooling effect of the supplied air eliminates much of the discomfort from radiant heat.

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Welding in Machine Design

By J. Mikulak*

PROGRESS in the application of welding technique in recent years has been little short of phenomenal. Design for welding has not made corresponding advances in as general a scope. This is, perhaps, partly due to the fact that technical knowledge was, to a great extent, principally developed as a post-mortem of difficulties encountered in the application of welding. However, at present, our schools and professional engineers are attacking this problem as a science to determine, if possible, the limits of the applicable range of each welding application. Therefore, we should expect an improvement in the condition existing in the past and, to some extent, today.

The economics of a welded design is, to a great extent, an individual problem with each manufacturer. Further, in a great many instances, it is also a function of the characteristics required by the particular industry in question, as well as the characteristics required of the particular product in question. The problem is further complicated by the facilities available in each organization, as well as the facilities located within a workable radius of this organization.

As an illustration of this fact, let us assume the same product being produced by four manufacturers: one has excellent and modern steel casting facilities; another has splendid forge facilities; still another has very efficient press and tooling equipment, and lastly, one does not have any of the above facilities, but does have an excellent and well-experienced shop organization.

It is likely that the first manufacturer will find it possible to incorporate the use of steel castings for various elements going into a welded structure. By the same token, the one with forging facilities will, no doubt, find it possible to use forgings in place of the castings used by the former, and the manufacturer with the press equipment may find it economical to make use of pressings. The organization without these facilities and equipment will, no doubt, find itself hard pressed in competition with the former organizations—and especially in mass production manufacture. However, due to the fact that the organization is efficient and well organized, it may still produce satisfactory results by using a considerably greater number of elements fabricated to required shape and welding them together. From the foregoing, it can be anticipated that the design approach will be materially affected by the type of equipment available for manufacturing. A weldery such as maintained by the American Car and Foundry Co. must have these facilities to enable the organization to serve the industry to the best advantage.

In each of the cases mentioned previously, there are fundamental factors that must be adhered to in order to obtain best economy and performance, which are listed as follows:

1. Eliminate welding where possible and use welding technique and equipment to produce the most economical results.
2. Use materials whose weldability is as good as possible. If special alloys are required, use them only on members where it is necessary.
3. Produce designs where good fitup is easily obtained and, at the same time, will not call for excessive amounts of welding.
4. Use as few elements as possible to compose the weldment consistent with quantity being produced.
5. Make design so that as little handling as possible is necessary during its fabrication.
6. Eliminate as much direct labor as possible to produce the weldment.
7. Eliminate machining and straightening operations on the final weldment to greatest extent possible.
8. Make joint design so that stresses are well balanced.
9. Make design so that welding is uniform about the neutral axis of the structure, as well as of each joint.
10. Study each joint from a metallurgical and stress performance standpoint. Also, wherever possible, make the joint design so that requirements of the welding technique and operator's skill are held to a minimum.
11. Study the design to determine if it is adequate to accommodate equipment to be used by the shop organization.

Each of the factors pointed out previously should be elaborated upon to further qualify their importance. These will be discussed in the same numerical order as previously given:

1. Elimination of welding, wherever possible, is stressed because of the fact that cost of welding generally exceeds the cost of making joints by means of pressing or incorporating a number of elements in castings, forgings or pressings. The cost per pound of metal deposited by the arc-welding process may vary from 70¢ to $3.00 per pound. This fact takes on more importance as the size of the structure increases, as it would take proportionally less time to bend or press a longer plate to form an angle rather than to weld two plates to produce same. The welded special low-swing lathe bed in Fig. 1 illustrates this principle. In the bed plate shown on Fig. 1, the bottom pan is a channel pressing. The apron and the inner member of the pan are also made as a pressing. All pressings are made in a standard press brake with standard dies. The ends are also pressings made in the same manner. This procedure saves approximately 100 ft. of welding on the unit and further improves appearance.

Another point of interest is the box beam which is incorporated and concealed within the unit and, thereby,

* Chief Engineer, ACF Welded Products Div., Berwick, Pa.

Fig. 1—Welded Lathe Bed for Special Low Swing Lathe

forms a container to hold coolant, as well as performing a functional duty of supplying the rigidity necessary to support the tail and head stock.

Note should also be made that considerable oil tight welding is eliminated which would further increase cost of the structure, if welded from plates.

Careful consideration should also be given to the amount of welding specified both for size and footage. In skip welding, the unwelded section generally should be greater than the length of the weld or otherwise the cost to break and start the arc will overcome the decreased footage.

The amount of welding can also be controlled by the type of joint being specified. Joints can be made in two methods; one in which the joint is primarily made by penetrating the edges of the parent plates, and, thereby, melting them to finally produce the joint upon cooling, and the other by producing the joint by melting the electrode from the welding rod. However, the former method will produce welding joint speeds of approximately 80% greater than in the latter method and, at the same time, decrease the electrode cost approximately 60%. The type of joint specified must also be ample for the type of load and intensity of stress to be placed upon it. It is important to point out that in some cases the joint produced merely by penetration will not produce as good performance in fatigue as joints made by deposition.

When welding must be ground to improve the appearance, the grinding may radically affect cost and, therefore, a bend made by use of dies is very desirable. Also, when working with materials, such as stainless, fabrication by pressing may decrease the finishing cost considerably over that when welded areas must be refinished.

However, when requiring the shop organization to fabricate joints by means of bending or pressing, it is important that proper material is furnished to eliminate cracking in the bending operation. This requires not only specifying the material to obtain the proper ductility but also the forming codes to which the plate should be rolled; that is, for instance, cross rolled. Material must also be ordered so that bends may be put in proper direction to the forming codes to which the plate is processed. Wherever possible, bending or pressing should be done cold for lowest cost, as well as providing better fit-up by keeping plates straight without resorting to straightening. However, bending cold requires proper contours and also keeping ductility requirement below that of the value from physical test. In simple right-angle bends for cold work one to two times the metal thickness is used for the radius to inner face of the bend.

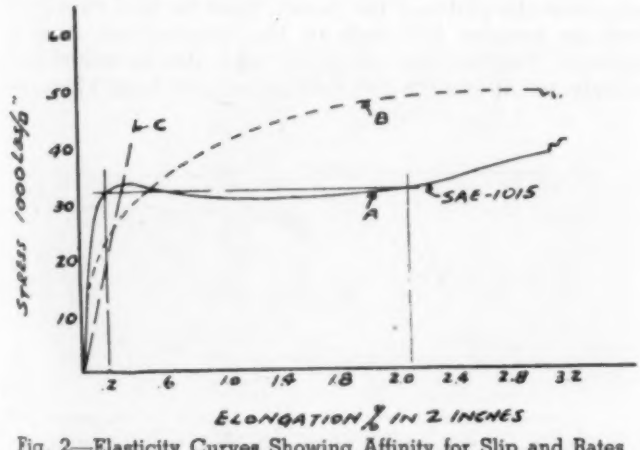


Fig. 2—Elasticity Curves Showing Affinity for Slip and Rates of Slip at Various Stresses

It should also be borne in mind that the total welding cost depends on three factors:

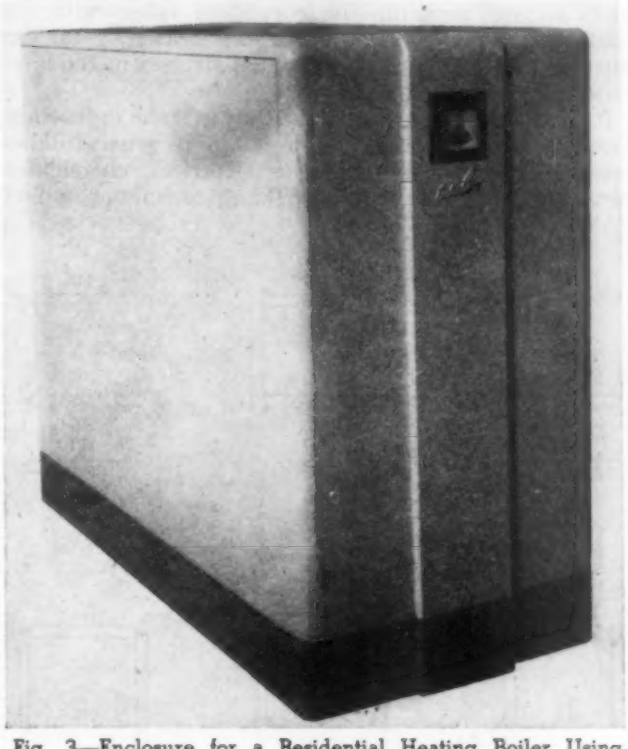


Fig. 3—Enclosure for a Residential Heating Boiler Using Sheet Steel and Standard Air Drying Enamel

(*a*) Preparation
(*b*) Welding Operation
(*c*) Finishing Operation

In preparation, the plates may be sheared or torch-cut but may produce poor fitups so that the welding and finishing costs may increase and, therefore, in instances where the type of tools to be used for shearing or torch-cutting are not precision, it may be economically feasible to machine the weld preparation and, thereby, obtain the lowest overall cost. It is also possible to make special joint preparations by machining so that larger electrodes can be used and, thereby, actually decrease the total welding cost through the greater rate of deposition obtained in the welding operation.

2. Most metals can be fabricated by welding; however, some of these metals require considerable care in preparation before the welding operation, as well as during and after the welding operation. This work increases the cost of welding appreciably. There are other metals, such as the open-hearth steel, in which very little preparation is necessary and minimum skill during the welding operation is required. The latter necessarily decreases welding cost and, therefore, whenever possible,

material with maximum weldability should be used in designs.

It should also be noted that some of the richer alloys may also be welded with great ease if proper type of equipment is used, such as used in flash or butt-welding processes. However, the latter is limited to cases where special setups are economically feasible because of the quantities involved.

Figure 2 illustrates the effect of ductility of the metals being welded, which is an important factor in producing ease in the welding operation. The curves show characteristic stress-strain values of three materials in which curves A and B are for ductile materials and Curve C for a brittle material. In Curve A, considerable strain can take place before stresses are brought up over the yield point. This phenomenon will allow welding distortion to take place without causing injury to the structure. On the other hand, a material as shown by Curve C produces stresses very rapidly to rupture values with very small values of distortion. For this reason, great care must be taken to eliminate residual stresses in the latter materials.

It should also be brought out that in some industries a product must be designed; wherein it generates best possible characteristics such as electrical, chemical or metallurgical. The type of welding technique applied,

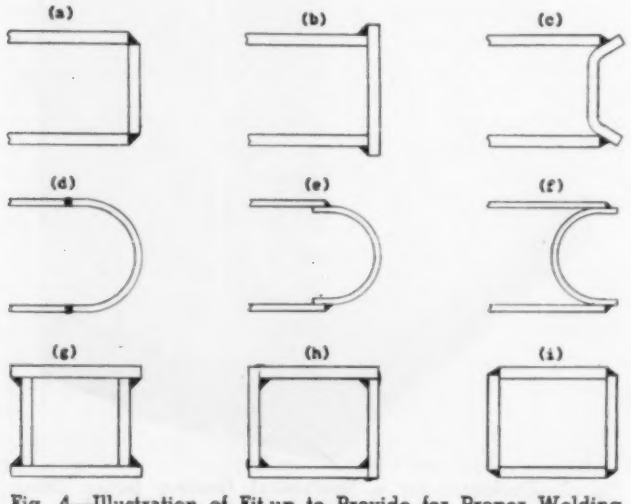
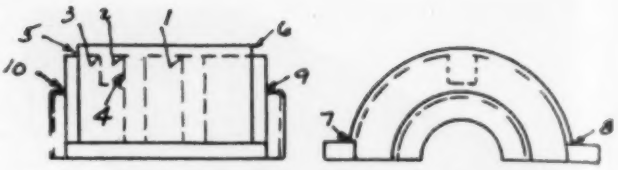


Fig. 4—Illustration of Fit-up to Provide for Proper Welding Technique

very likely, may not be the most economical but rather one that will produce the most desirable performance. Therefore, the designer must avail himself the characteristics of the various welding techniques and weigh the results produced against the probable cost. Further, the stress distribution and type of load may also make it necessary to resort to special welding techniques or use of a design—not necessarily the most economical in cost but rather in the interest of proper performance.

There is a considerable amount of selling being done to influence the use of light alloys, such as aluminum, stainless, etc. The final decision must take into account savings in pay load, finishing, corrosion properties, durability, decrease in operational cost, maintenance, abrasive, ease of fabrication and others; such as heat resistance, chemical and electrical properties. Care should be taken to include consideration of the effect the welding operation will have on the material and cost necessary to re-establish original properties of the materials at the weld zones.

Another important consideration, which may be apart from any sound engineering principle, is "sales appeal" or



Welding Sequence: Joints 1, 2, 3, 4 and 5 In positioner 45° from vertical. After welding joint 3 hammer down block and weld joint 4 in vertical down position. Swing cap in jig and make joint 6 in 45° from vertical. Turn cap in horizontal position, rotate 45° and weld joint 7, then turn 135° and weld joint 8. Fit cap to base and weld on seals at joints 9 and 10.

Fig. 5—Welding Sequence for a Pedestal Cap

generally termed as "eye appeal." However, in a good many instances, the latter can also be accomplished less costly by a well-balanced design rather than burdening the design by an overwhelming display of special material. Attention should be paid to the style lines of the product so they blend in with the surrounding atmosphere in which the article is to be operated and, thereby, accomplish much in sales appeal without the use of costly materials or finishes. Figure 3 illustrates an enclosure for a heating boiler being produced by the American Car and Foundry Co., wherein styling produces good taste and eliminates special finish.

3. Fact should always be borne in mind that any manufacturing process must have tolerances with which to work to produce the product. These tolerances allow for variations in the performance of the various fabricating equipment used to fabricate the parts before final assembly by welding, as well as on the welding operation. It should be borne in mind that closer tolerance requirements mean greater cost because generally better equipment is required with correspondingly increased maintenance cost to keep this equipment operating more exactly. Further, increased cost will also be noted in labor to produce these parts, as well as cost necessary to inspect these parts.

Ingenuity in design will make it possible for plates to lap over each other on the unimportant dimensions of the structure and, thereby, decrease labor necessary to obtain good joint fits. The effect of poor fitup on cost can be visualized when considering that the welding speed is reduced 65% when welding on $^1/_8$-in. material with a gap equal to the thickness of the material. On $^1/_2$-in. material, the same joint speed is reduced 75% with a gap equal to one-half the thickness of the material.

Figure 4 illustrates the application of good fit-up and also corresponding decrease in maintaining close tolerance on fabricated parts.

Figure 4 (*a*) illustrates either a circular or rectangular flat end vessel; wherein the dimensions on the diameter, or across the plates of the vessel, must be held closely, as well as keeping the ends of the longitudinal member square. Further, the end plate must also be maintained closely to dimension and flatness as any large clearance

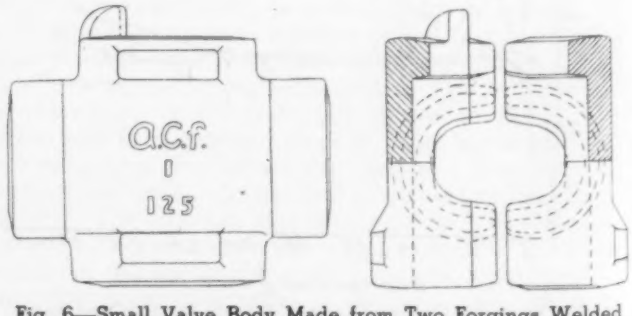


Fig. 6—Small Valve Body Made from Two Forgings Welded Together

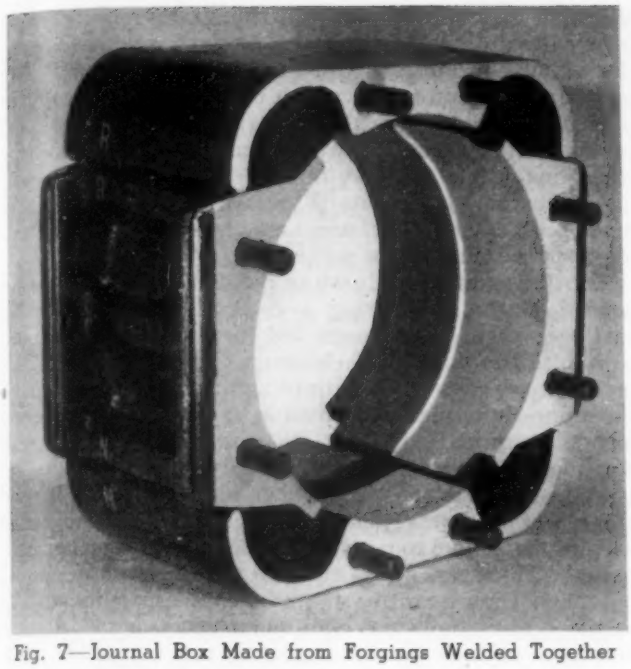


Fig. 7—Journal Box Made from Forgings Welded Together

provides a bad fit-up and, consequently, creates difficulty in building up welds. This joint is further very difficult to use with an automatic welding technique.

Figure 4 (*b*) improves the condition with respect to dimension tolerances on the plates but longitudinal plates must still be square and end plate flat. However, conditions are improved considerably as more thermal capacity is provided at the gaps, if any exists, making it possible to build up gaps. This joint is further much more desirable for an automatic welding process.

In Fig. 4 (*c*) the end plate is a shallow pressing in which the ends are pressed up on a taper. In assembling, it is only necessary to tap the end plate into the vessel until it is only necessary to tap the end plate into the vessel until it is tight all around the periphery and thereby produces an excellent fit-up for either the manual or automatic welding process.

Figures 4 (*d*), 4 (*e*), and 4 (*f*) illustrate the same analogy for a tank with spherical ends. Mention should be made of the fact that stress conditions should also be considered, as stress flow in joints shown in Figs. 4 (*c*) and 4 (*f*) are not desirable unless stresses are of low value.

Figures 4 (*h*), 4 (*g*) and 4 (*i*) illustrate two parallel plates whose dimension must be maintained. In Fig. 4 (*h*) all plates must be kept to dimension and further kept square, but in Fig. 4 (*i*) there is no need of keeping any of the plates to close tolerance as they lap each other and can be assembled to obtain proper dimension. Good

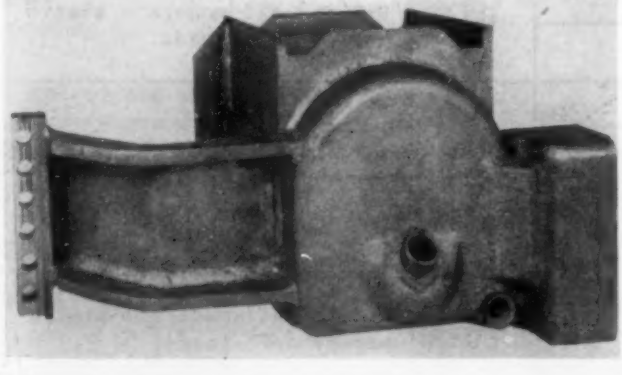


Fig. 8—Journal Box Made from Forgings, Pressings, and Torch-Cut Ears

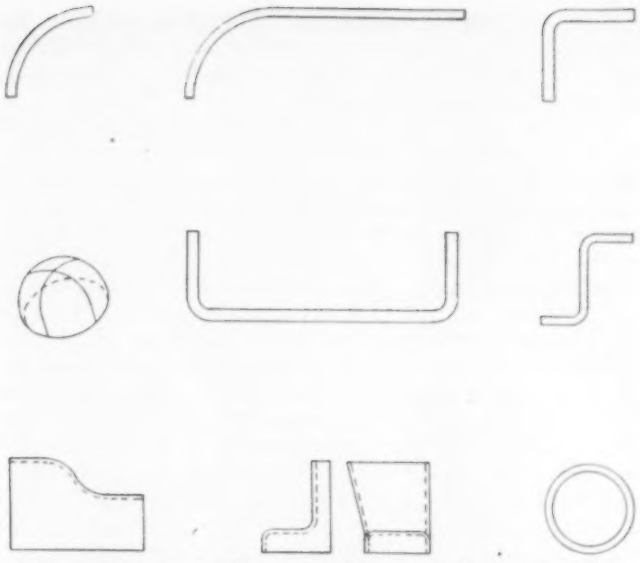


Fig. 9—Suggested Shapes Useful in Producing Low-Cost Weldments

joint fits decrease the amount of welding required and also produce less distortion in the structure during the welding operation. This fact is also brought up in the first rule referred to in that poor joint fits increase the amount of welding necessary. A considerable latitude in tolerance on the final product is possible in the welding operation itself by standardized procedures and by use of proper welding jigs. In setting standards, information, such as type electrode, electrode size, current, voltage, type of welding equipment, size of weld, number of passes, welding position, welding arc speed, etc., should be given. In automatic arc welding, size and type of flux should also be given. When other forms of welding are used, such as gas, inert arc, resistant, stud welding, etc., pertinent data should be given as to manipulation of the equipment to obtain uniform results.

In addition to the foregoing information, a fabrication sequence should also be supplied showing the chronological order in which the various elements should be added to the assembly, how they should be clamped or tack welded, as well as in what sequence each should be welded. Figure 5 illustrates a sequence for a welded cap assembly.

In producing welded jigs, it is important to have in mind that a welded structure sets up thermal forces which, in some instances, set up forces on the jig considerably in excess of the forces to be placed on the com-

Fig. 10—Rotator to Position Hopper for Welding

pleted structure in operation. Therefore, welding jigs should be very rigid, that is, stiffer than the weldment, especially when good dimensional stability is required on the weldment being produced.

It is also important to bear in mind that distortion will be set up in the weldment, and care should be taken that the unit being produced can be removed from the jig very readily. Jigs should also be made to allow for distortion in welding so that the finished weldment will be to the size required. To facilitate the latter, drawings should specify limits on all dimensions for fabrication of parts, as well as the assembly of the weldment. It is for these reasons that difficulties are encountered when using jigs for welding which are built to conventional design for machine tool application. Caution, at times, must also be taken when making machining jigs for welded assemblies in that clamping devices must be placed so that the assembly is not distorted by clamp pressure. Because of foundry practice, castings are sometimes made heavier than necessary and are apt to be ribbed generously. This is not necessary with welded assemblies and, therefore, localized areas may be somewhat under the stiffness of castings, and consequently better clamping load distribution should be allowed on the welded assembly.

4. In a great many instances, considerable cost reduction can be accomplished by taking several elements composing the weldment and making them integral in the form of a pressing, forging or a casting. This will eliminate a considerable amount of welding and will also eliminate a considerable amount of set-up cost, as well as fabrication and assembly cost. In a good many instances, it is possible to take castings and change the design so that the unit is made up from several cast elements which can be welded together and, thereby, decrease the cost over the casting in an integral unit. This is made possible by eliminating core work necessary when making the integral casting. In a good many cases, the smaller cast patterns can be mounted on a board and several castings poured in the same mold.

The American Car and Foundry Co. has developed two interesting examples following this analogy that are shown in Figs. 6 and 7. Figure 6 illustrates forgings made for small valves which later can be flash welded to make the valve housing. Figure 7 illustrates a journal box made from four forgings which can be automatically or manually welded and, thereby, produce an economical product with decreased weight, as well as eliminating rejections due to porosity obtained in the integral casting. Further, economy is gained in elimination of machining external surfaces and also reducing machining required on interior surfaces.

Another example is shown in Fig. 8 illustrating another welded journal box using a design approach wherein castings, forgings, pressings and torch-cut bars are used to reduce the number of elements to a minimum. This procedure assures a box with minimum distortion and, at the same time, makes it possible to eliminate machining formerly required. Further, it is possible to use materials with desired physical properties only where actually required, such as in the top member where a forging is used of greater hardness than on other members, to resist peening forces due to pounding action of the bearings contained. However, in resorting to the latter, care should be taken that quantity requirements are sufficient to justify cost of tools and equipment necessary. In some instances it may be advisable to make use of these methods to get required performance in the design from a functional or appearance standpoint.

To assist justifying tooling programs, it is possible to study the organization's needs for standard parts or elements which can be used effectively on a number of different products being manufactured. Elements such as spherical corner inserts, supporting legs, special pressed channels, spherical or special shaped pressed heads, hinges and latch parts, etc. Figure 9 illustrates a few elements which can be worked into many products.

5. Oftentimes the design can be made so that all joints can be reached from one side of the weldment, thereby, making it unnecessary to turn the unit over to get at the joints which ordinarily would only be accessible from the opposite side of the weldment. In some cases, it is possible to locate the joints so that they come on one

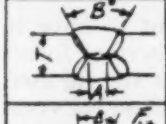
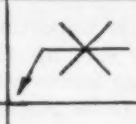
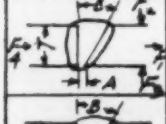
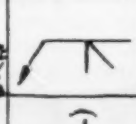
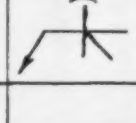
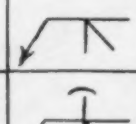
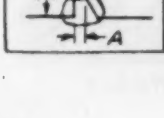
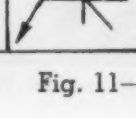
Section	Welding Symbol	Thickness T	Root Opening "A"	Bevel Angle B°	Reinforcing 2"	Max. Eff. %	
		1 3/4	3/16	80	1/4	100	Use for all loads.
		3/4	1/8	60	1/8		
		3/4	5/32	60		70	F_1, F_2, F_4 may be static or moderate dynamic loads. F_3 moderate static loads only.
		1/4	1/16	40			
		3/4	5/32	60		80	Use for all moderate static and dynamic loads.
		1/4	1/16	40			
		3/4	5/32	60	5/32	80	Use for moderate static and dynamic loads except F_3 use only static and light dynamic.
		1/4	1/16	40	3/32		
		3/4	5/32	60	5/32	90	Use for all loads
		1/4	1/16	40	3/32		
		1 1/2	5/32	60		60	Use for all moderate static and dynamic loads.
		1/2	1/16	40			

Fig. 11—Joint Procedure Showing Necessary Dimensions and Engineering Data

or two sides of the weldment instead of all six sides. This further reduces the handling, as well as the time necessary for moving around the weldment to get at the joints to be welded. However, it is important to note that, generally, the latter procedure will produce higher residual stresses, and where dimension stability is necessary without stress relieving, it may be necessary to deviate from this procedure to obtain results required.

The use of positioners made to properly support and rotate the structure being fabricated will assist in reducing handling time. A special jig shown in Fig. 10, as developed by the American Car and Foundry Co., handles a complete hopper railroad car and, thereby allows practically all welding to be done in one position. This jig not only reduces handling but also minimizes movement by the operators to get at joints and at the same time places joints in a flat position for faster welding speeds. During fabrication, considerable handling can be saved if a fewer number of bars or plates must be handled to obtain material for all the elements of the structure. Further economy is gained in making it possible to reduce amount of scrap by making smaller elements from scrap obtained in fabricating the larger elements. Additional economy is gained in reducing inventory costs and also material cost in making possible more mill purchases rather than warehouse. Problem of keeping steel properly tagged for identification is also simplified.

To facilitate the latter program, it is desirable to standardize on a definite number of sizes and grades of bars, structural shapes, plates and sheets and make it compulsory for the design section to be confined by same and generally approval to use exceptions should be made very difficult and, thereby, act as an incentive to facilitate the latter program.

6. An important consideration, not only in the welding field but the industry in general, is elimination of as much direct labor as possible in the production operations. This fact is gaining more importance as the cost of labor is increased and at the same time productivity is maintained at a low standard or decreased. High labor rates do not impair production costs if productivity is increased at the time labor rates are increased. Unfortunately, at present, labor rates are increasing with generally the same or decreased productivity and, thereby, proving to jeopardize our cost standard which may prove to be a hurdle in obtaining export trade, especially when our flow of money to foreign countries is stopped.

Operating factor or fatigue should also be kept in mind when working out a design, in that 20% decrease in performance will increase cost 30%, and 80% decrease in performance will produce a cost increase of approximately 500%. Fatigue can be overcome, to a great extent, by providing proper jigs and also correct type of welding equipment for the material being welded. As an example, with majority of the a.c. welders, a decrease in operating factor will be obtained when welding on light materials in that the arc starting characteristics of the a.c. welders are not as desirable as those obtained with d.c. units.

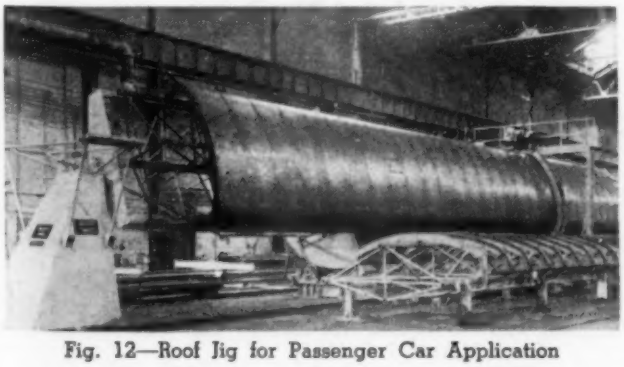


Fig. 12—Roof Jig for Passenger Car Application

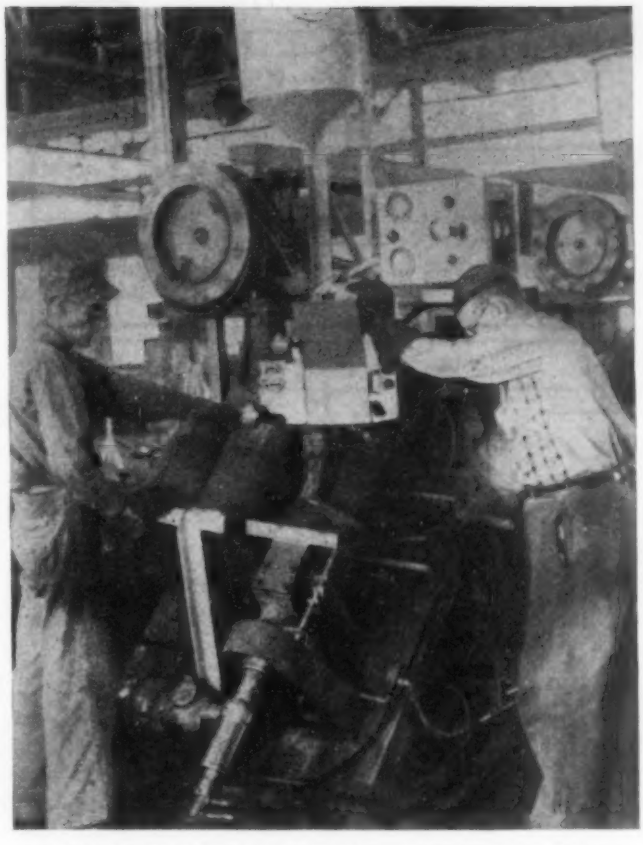


Fig. 13—Welding Jig for Welding Tube to a Flat Plate

There are several types of joints which can be produced with considerably less welding and fabrication labor. In some instances, a substantial decrease in welding cost is produced with a small increased fabrication cost and, therefore, for most economical results should be used. This factor is especially important on heavier members. In addition, new equipment, such as the semiautomatic welding machinery and inert gas-shielded arc, produce joints with considerably less joint preparation cost. However, in the latter, good tools are necessary to give precision fabrication so that good fit-up is obtained. A joint procedure, as shown in Fig. 11, giving pertinent engineering data as to dimensions and advisability of strength and location of same will prove of great assistance to the shop and engineering sections in correct joint application.

Direct labor can be eliminated by providing better tooling and better jigging. This is especially important if a tool can be produced as a capital expenditure making the tool usable on a number of jobs and, thereby, decreasing its amortization rate. Where production warrants producing special jigs, such as shown in Fig. 12 to make use of automatic equipment, considerable operational cost can be eliminated. The jig shown in Fig. 12 was developed for the American Car and Foundry Co. and is used to assemble and weld a complete passenger car roof. An automatic submerged arc-welding machine is used for welding the joint at approximately 100 in. per minute.

Another adaptation of automatic production is illustrated in Fig. 13 which is another clamping, positioning, welding and unloading jig. The jig is used for making a circumferential weld, such as a tube to a flat plate. The tube and plate are fed into the machine and automatically clamped by means of an air jack. The machine starts an

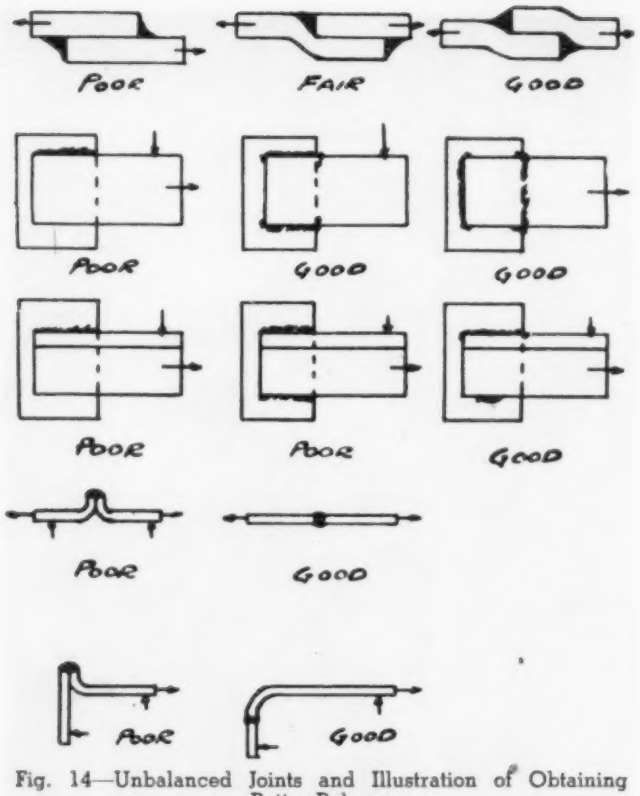


Fig. 14—Unbalanced Joints and Illustration of Obtaining Better Balance

automatic submerged arc after which it starts to rotate the tube and plate through an angle of 370°. The welding arc is broken automatically and at the same time releases the air jack to finally eject the welded tube and plate from the machine. The largest assembly, so far used, completely positions an $8^3/_4$- x 15-in. long tube to a $^3/_4$- x $9^1/_2$-in. plate, clamps, welds and unloads the assembly in less than 1 min.

It is further possible to decrease direct labor by extending the usefulness of the various techniques involved in the manufacturing operation to its greatest limit. In some cases it is possible to design tools and fixtures where they may drive the operator, such as shown in Fig. 13 and, thereby, force productivity.

Proper incentive studies will also assist obtaining productivity and, therefore, methods' personnel thoroughly experienced with shop methods should set up rates or standards. When making time studies, the time study representative should be able to correctly evaluate the effort being produced by the operator and also observe that proper fit-up technique and tools are being used during the study. If new or better tools are contemplated, studies should be made to determine their effects.

7. A good deal of economy may be obtained by the use of weldments in eliminating subsequent operations, such as machining. It may be possible to eliminate one rough cut over that required with the casting and, in many instances, it is possible to eliminate machining entirely. Further, it is possible to produce holes by punching in the fabricating operations instead of drilling as required on a casting.

When using forgings or castings as elements, care should be taken that parting lines are most advantageously located to reduce preliminary machining or grinding operations. In using forgings, use should be made of sheared faces produced by the trimming operation to obtain better welding fit-up. When possible, forgings with important faces, which must be flat and smooth and ordinarily would be machined, should be designed so that these faces are perpendicular to the stroke of the forge hammer and in the top die and, thereby, insure the position of best flow and freedom from slag or dirt. Subsequent coining operation will generally prove economical by providing faster and better fit-up and, thereby, decrease assembly and welding labor.

Stress or strain relieving should be resorted to only when necessary from a safety, load performance or dimension stability standpoint. It should be borne in mind that a weldment will age similar to a casting and, if possible, should be allowed to do so even though it has been stress relieved when extreme precision must be maintained on finished structures.

When using alloys or open-hearth materials with medium carbon, the structure should be normalized to reduce machining difficulties. In many instances, a stress-relieving operation can be combined with a normalizing operation by using the same heat cycle to accomplish both objectives and, thereby, reduce operational cost.

8. A factor important to this discussion from a standpoint of performance of the weldment, as well as of cost, is one of placing the welding so it does its work most efficiently. In fact, it is possible to considerably decrease the amount of welding required if the welding is placed correctly to distribute the intensity of its strength uniformly over all the welding in the joint. When static loads are encountered in heavy plate, complete penetration may not be required and, therefore, unnecessary cost should not be resorted to to obtain same. However, when designing units for rigidity, the welding should be of sufficient strength so that the members function correctly. This is especially important when natural frequency is being designed to be removed from interference with impressed frequencies. Insufficient amount of welding will not produce a single mass but rather a complex problem of several masses acting under dampened conditions from adjacent members. Further, the welding should be, where possible, placed so that it will not develop stress risers by discontinuities characteristic of the welding technique; that is, change in ductility, undercut, excessive build-up, etc., and, therefore, subject the joint to fatigue.

It is interesting to note that considerable build-up of reinforcing weld material will act as a detriment to the welded joint and at the same time increase the cost of the welding operation.

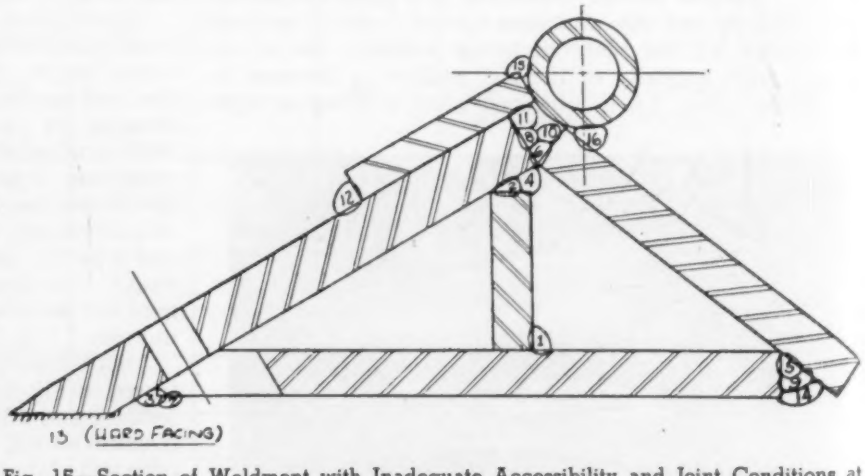


Fig. 15—Section of Weldment with Inadequate Accessibility and Joint Conditions at Beads Marked 2, 5, 11, 16

Figure 14 illustrates several unbalanced joints under several types of loads and also suggestions as to how they can be improved. Particular attention should be paid to the fact that, where possible, a balanced couple should be produced within the joint to set up resistance to the applied load. As an example, assume a case such as the angle iron welded to a vertical member to act as a cantilever beam. Due to the fact the neutral stress zone of the angle is not equidistant from the two fillet welds, one weld will have considerably more resistance about this zone when both welds are of the same strength. Therefore, this weld tends to take up more of the load because of nonuniform strain distribution at the welds and, thereby, creates a stress riser on the weld.

9. Welding procedure and fabrication sequence can also materially influence the amount of welding necessary. Structures can be welded in two broad classifications in which one produces high residual stresses and small distortion and the other lower residual stress with considerably greater distortion. In the former, care should be taken that weld beads are ample to resist the residual forces set up.

To hold down distortion and also to decrease the stiffness necessary in jigs, the design should be set up so that the welding is uniform about a neutral axis through the structure. It is also helpful if the same theory could be followed at each joint. For instance, a butt weld between two members produces less distortion than the same two members being welded together by a fillet weld. The same thing is true of a disk being welded into a ring where a V-joint is used in place of the fillet weld.

The suggestions just given indicate that the fit-up cost may increase when resorting to these practices. However, if production requires precision and freedom from warpage, this procedure must be resorted to obtain the results required. It is possible, when necessary, to use a small filler made from a material with a low yield point and high ductility, such as a copper wire. The latter is useful on heavy sections to reduce the amount of residual stress on the welds and still maintain small root openings to minimize distortion.

The remark "that the weld is stronger than the parent plate" is quite frequently made but does not always prove to be true, and generally, inadequate provisions for taking care of residual stresses account for its undoing.

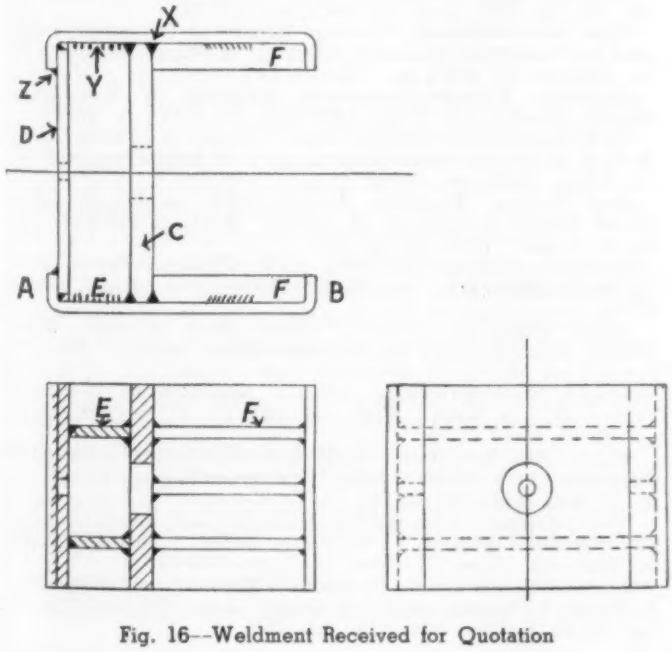


Fig. 16—Weldment Received for Quotation

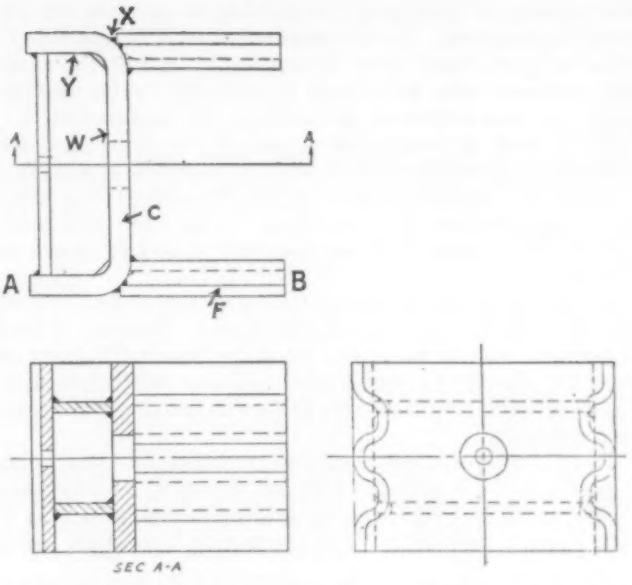


Fig. 17—Weldment Shown in Fig. 14 After Being Redesigned

10. The thermal capacity of the material at the joint should be studied when determining the size of weld specified. Further, on multiple pass work, it is important to specify the size of the first pass so that undue cooling rates will not exist tending to set up brittle deposits at the root of welds which, when stressed, would act as stress risers. Conversely, it is also important that excessive welds are not specified for the thermal capacity of the joint involved, as excessive oxidation may also decrease the physical properties of the joint.

When welding some of these special alloys, the size of welds specified is also important from the standpoint of maintaining the original characteristics of the parent alloys. Improper heating caused by the welding will, in some cases, destroy the properties originally intended but, in most cases, they can be restored by heat treatment. In the latter case, it is important that the most suitable equipment is used not only to maintain the metallurgical properties but also to reduce the operator skill required so that more uniform results can be obtained in production.

Another important consideration in this respect is to study design to determine that it will be possible to produce all joints by providing sufficient accessibility for welding and also proper joint conditions to get suitable joint results from stress flow and metallurgical characteristics. Figure 15 illustrates an assembly where joint conditions and accessibility are not the most conducive for good results at beads marked *2*, *5*, *11* and *16*.

11. After all considerations have been given, the design should be thoroughly checked to determine that adequate equipment is available in the shop to produce the weldment with proper cost performance and with acceptable quality of workmanship from the standpoint of performance, as well as appearance. The industry today is critical of appearance for equipment going into obscure and remote operating locations, as well as that in more prominent locations. This fact is true in railroad equipment, as well as in a weldery, and, therefore, constant effort is being expended to improve appearance by providing better tools and also improving shop techniques.

Structures can be designed so that the external appearance is embodied with the functional elements of the structure and, thereby, impart stiffness to same. However, structures may also be designed to economic advantage by building the unit as functional as possible and

later adding a cover plate or housing to provide the external appearance. In this manner, it may be possible to enhance appearance very economically and at the same time promote sales advantage by not only better appearance, but also increased accessibility for maintenance.

To provide a concrete example of the principles discussed previously, Fig. 16 illustrates a weldment as it was received by the American Car and Foundry Co.'s weldment organization for quotation. This unit was redesigned before quotation was submitted and is shown in Fig. 17.

In Fig. 16 it was necessary that the ends *A* and *B* were exactly to length and in parallel planes. Further, a load of ten tons was to be placed on plate *C* and $1^1/_2$ tons on plate D. Load at joints *A* and B also to be ten tons and, therefore, ribs *E* and *F* were added to provide the necessary stiffness.

To take care of these loads, heavy welds were necessary at positions *X*, *Y* and *Z*. Further, it would be necessary to specify rigid tolerances on side pressings at *A* and *B* with a good possibility of a machining operation being required at these positions later. Further, the heavy welding at *Y* and *X* will tend to warp plates *C* and *D* which must be flat and parallel to faces *A* and *B*. The design as shown in Fig. 16 required 12 members with 25 ft. of single-pass welds.

The redesign as shown in Fig. 17 requires six members and $12^1/_2$ ft. of single-pass welding. Further, plate *C* is formed as a hot pressing, thereby producing a flat surface at *C*. The two ends are torch cut simultaneously with two heads mounted on a torch-cutting machine and running on the face of the pressing. Large welds at *X* and *Y* are not required and, therefore, produce minimum distortion.

In the welding, plate *C* is placed in a jig located from *A*, and sideplates *F* are located in the same jig from *B*. Welding at *Y* is completed before welds at *W* are made to reduce residual stresses otherwise imposed on this weld.

It can readily be seen why the cost should be reduced with the latter design and at the same time produce a better product without resorting to machining.

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New Applications of Inert-Arc Welding*

By R. W. Tuthill†

THE Inert-Arc process is one of the fastest growing and most versatile methods of welding used in industry today. It is a welding process which uses a nonconsuming electrode to hold an arc in an atmosphere of inert gas. In 1930, patents covering the welding of metals without flux in atmospheres of argon and helium were issued to Hobart and Devers and assigned to the General Electric Co. As early as 1940, helium gas was used to shield welds made on magnesium, but the applications of this metal have been outweighed since by applications of the process on aluminum, copper and stainless steels.

In order to apply any welding process properly it becomes necessary to evaluate the characteristics of the process in order to utilize it to best advantage and prevent misapplications.

The Inert-Arc process uses no flux consequently this expense is eliminated. The cost of applying and completely removing flux after welding accounts for a large portion of the total welding costs particularly when welding aluminum.

The area of metal melted under the arc is relatively small compared to other processes. This concentration of heat is a very decided advantage since it helps to control distortion. In the welding of stainless steel the narrow heat zone tends to minimize carbide precipitation in the heat-affected zones.

In a great many welding applications no filler is required. This process is ideally suited for this type of work since the tungsten electrode usually employed is not consumed in the welding operation.

The problem of oxidation of the weld metal is completely controlled in this process by the use of an inert gas envelope which surrounds the arc. This gas can be either argon or helium. Both these gases are noncombustible and limit oxidation because they prevent air from contacting the molten metal.

The equipment required to do this type of welding is very compact. An electrode holder to grip the tungsten electrode, a cylinder of gas, a pressure regulator and a welder are all that is needed. One type of electrode holder is capable of welding from 0.020- to 0.250-in. thick material. This makes the process very versatile.

One application of this process has been its use in fabrication of beer barrels. Welded containers are now being made which are superior to the old wooden types.

Both aluminum and stainless steel barrels are being welded by the Inert-Arc process.

The fabrication process consists of drawing the two ends of the barrel and making one or sometimes two circumferential machine welds in the center.

The bung holes for filling are welded in manually. The Inert-Arc process enabled the manufacturer of these barrels to make a better product more economically.

A manufacturer of Diesel engines changed his design to incorporate aluminum pistons. The design consisted of a cast aluminum body with a forged aluminum ring. These two parts were assembled with a shrink fit. In spite of this, gases from the combustion chamber would reach the oil passages in the piston through the joint between these two parts. It became necessary to find a way of eliminating this difficulty. One-piece pistons were out of the question both from economy and difficulties in design. Welding was the answer but with all other welding processes distortion and flux removal were serious problems.

The Inert-Arc process was utilized to weld a sealing bead without filler on the piston head at the joint between the body and ring. The joint did not have to have complete penetration and if other methods of welding using flux had been used it would have been very difficult to remove the flux from the root of this joint.

The application of the Inert-Arc process to this job resulted in the solution of this manufacturer's problem.

A superintendent of a steel rolling mill recently authorized the installation of Inert-Arc welding equipment to enable the mill to handle long coils of stock without shutting down.

The problem consisted of continuous rolling of sheet up to 0.250 in. thick. The coils that were supplied to the mill would permit about $^1/_2$ hr. of continuous operation. It was decided that for the economy of higher production a traveling welding fixture with a looper pit would be installed. The coils were to be butt welded with no filler. The Inert-Arc process will permit the welds to be made quickly with no spatter and with a minimum of joint preparation and post-welding cleaning. As the end of one coil approaches the welding fixture it is sheared and clamped; the new coil end is also sheared and clamped so as to butt against the old coil end. The welding fixture travels down the line as the welding head traverses the joint. The Inert-Arc process enables sound welds to be made at high speed with very little spatter.

By the use of this process it was also found that sheets of unlike thickness could be butt welded. This will enable the operator to thread a new run of different thickness material through the rolls without a time-consuming and costly threading operation.

The mill will be used to roll Type 304 stainless steel, high-chrome steel and some high-carbon steel. Several lines will be used to accommodate from 0.008, to 0.250-in. material. Welding speeds as high as 50 in. per minute are anticipated.

The Inert-Arc process application in this instance will result in higher production at low investment and operation costs with a maximum of flexibility of the equipment.

A fabricator of tubing had his supply of seamless beryllium copper tubing cut off. He would have been able to use sheet stock if the welding problem could be solved. Investigation indicated that the Inert-Arc process was readily applicable. Inert-Arc equipment was installed on

* Presented at Twenty-Eighth Annual Meeting, A.W.S., Chicago, Ill., week of Oct. 19, 1947.

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a tube mill, and this process enabled him to weld this material with no flux and at high speeds.

The different applications of this process are almost too numerous to mention. Among them include the welding of fernico, an alloy with the same coefficient of expansion as glass and used in electronic tubes; the welding of silicon steel sheets, used in transformers; repair of aluminum castings; fabrication of refrigerators; manufacture of extruded window frames; welding of ice cream molds; and many others.

This widespread and rapidly growing use of this process indicates that it is one of the major advances made in the welding industry in many years.

Welding engineers are anxious to apply this process but before they can do this intelligently a knowledge of the welding characteristics is necessary.

The arc is maintained between the electrode, usually tungsten, and the metal to be welded. The arc is enveloped in a shield of inert gas either argon or helium. The arc produces a small easily manipulated molten pool. No flux is required or is it desirable.

Direct current may be used to weld most metals.

Alternating current is used to weld aluminum with the proper circuit to provide a stable arc.

However, with a.-c. circuits a characteristic of aluminum oxide is observed. This characteristic is called rectification. Rectification is the action which tends to prevent current flow in one direction while permitting current to flow in the opposite direction. This rectification action causes a direct current to flow while welding. This direct current may be a large proportion of the total current in the circuit and will cause overheating of the welder primary and secondary circuits. Such a d.-c. component may cause circulating current which can damage adjacent equipment connected to the same power source.

The d.-c. component and its inherent disadvantages can be prevented by means of a group of condensers in series with the welding leads which permit the welding current to flow but eliminate the d.-c. component.

This tends to prevent overheating of the welding cables and the welder.

It has been known for several years that welding arcs of low current density can be stabilized with the use of a continuously operating high-frequency, high-voltage, pilot current. One common method of obtaining this discharge has been with a high-voltage discharge through a condenser and a spark gap. The spark gap is part of a resonant circuit in series with the primary of an air core transformer whose secondary is one welding lead. This circuit, to operate satisfactorily, has to produce a high-frequency current across the arc gap. This helps to ionize the arc gap to make it easier to weld with low current. This type of circuit has been used for a number of years in metal arc welding of thin material. An auxiliary use of this high frequency has been to start the arc without touching the electrode to the work.

There are some advantages in the application of this circuit to Inert-Arc welding. If continuous high frequency is used, a clean pool can be obtained when welding with argon on aluminum with low open-circuit alternating voltages such as are found in metal arc welding. Although clean welds are obtained, the d.-c. component is still present and may result in the disadvantages noted above. There are some disadvantages to the use of a continuous high-frequency pilot in Inert-Arc welding. Most pilot circuit designs utilize frequencies which are within the radio communication and broadcast wave length bands. This means that every continuously operating high-frequency pilot spark is a small radio station which sends out static in every direction. It is hard to shield this high-frequency source and consequently a great deal of radio interference may occur. The maintenance on a continuously operating high-frequency pilot spark is quite excessive and frequent adjustment of the spark gap may be necessary.

Inert-Arc welding machines are being manufactured today which will produce clean sound welds in aluminum and magnesium as well as other metals, without the use of either a flux or continuously operating high-frequency pilot circuits. These machines are designed to block the d.-c. component of welding current by the use of series capacitors.

They also provide, by means of a foot pedal, a method of starting the arc without touching the electrode to the work. To accomplish this, a high-frequency pilot apparatus works only when needed and does not run continuously. This tends to minimize radio interference troubles.

Machines of this type are equipped with control systems including solenoid valves which provide for gas and cooling water economy.

It is usually practice to use either argon or helium gas, utilizing their different characteristics to get the best results, except on alloys such as aluminum and very thin material, helium is preferable to argon because helium produces more heat per ampere of welding current than argon, all other factors being equal. This applies to the welding of inconel, copper and stainless steel when d.-c. straight polarity is used. When magnesium is welded, d.-c. reverse polarity is used.

The arc voltage in helium is higher than the arc voltage in argon. Since the heat in the arc depends on arc voltage as well as arc current, helium then will produce more heat than argon and travel speed can usually be increased. When welding time is cut down, even though the rate of flow of helium would be greater (because of its lightness) than argon, the total gas consumption may be such as to make the helium the more attractive gas economically on some applications.

This characteristic of higher heat for helium (using the same current) than for argon becomes a disadvantage when welding very light gage metal such as $^1/_{32}$ in. thick. Here arc stability becomes a very serious factor. For a certain heat in the arc and the same travel speed an arc in helium would require less current than argon. Since it is advantageous to use the highest current possible on small electrodes in order to have good arc stability, it then becomes desirable to use argon instead of helium provided the finished welds in either gas are of equal quality. Another factor to consider is arc length, which can be changed when welding in argon without appreciably changing the heat input to the work. Therefore, arc length is less critical when using argon. On the other hand, the arc voltage arc length curve with helium has a very marked rise and is steep enough to permit an electronic panel to detect changes in arc length by measuring a change in voltage. Electronic panels available today will respond to arc voltage changes in helium, but not in argon, and so all automatic machine welding applications are confined to the use of helium gas. With the use of helium gas, then it is not necessary to have an elaborate fixture to hold a constant arc length, in fact machine welds can be made on contours which are irregular in shape, the electrode following the seam very accurately by electronic control.

Machine welding without automatic arc length control can be performed in either atmosphere if the seam is of such contour as to require little or no adjustment of the electrode during welding.

Electrode holders must be light in weight, easily manipulated, compact in size. They must grip the tungsten firmly and provide adequate gas coverage to the arc. In order to accomplish these things most electrode holders

are provided with water cooling which enables the welding cable to be small and the electrode holder to run cool.

The Inert-Arc process will produce a strong, sound, good-appearing weld at high speed on any application where a minimum of filler wire is to be added. It should be superior to most present welding methods for these applications. There is no common joint design on which the Inert-Arc process has not produced a satisfactory job. The process can be applied manually or with a machine with or without automatic arc control. Argon gas is used to weld aluminum and magnesium with alternating current, and light gage alloys with direct current, straight polarity (electrode negative). Helium gas may be used to weld magnesium, with reverse polarity (electrode positive) and most other metals, using direct current, straight polarity (electrode negative). Metals that have been welded with the Inert-Arc process include aluminum, magnesium, copper, inconel, everdur, beryllium copper, stainless steel, fernico, molybdenum, high zinc alloys, silicon steel and enameling iron.

Maintenance of Resistance Welding Equipment*

By F. R. Woodward†

THIS address is, to a considerable degree, a summary of personal views, and no indication of the official viewpoint of the Progressive Welder Co. In addition, some of my views are possibly biased because of my particular experiences and I would be very glad to have comments, criticisms and questions during the discussion period.

A welder manufacturers must always provide for expected maintenance and is always faced with the problem of designing equipment to minimize this maintenance. We feel this is a very important task.

Webster defines maintenance as "the act of maintaining" or "the state of being maintained." He further defines "maintains" as "to keep in a state of efficiency" or "bear the expense of." Quite aptly, the literal meaning, derived from the Latin or French, is "hold by the hand." It often appears that it is necessary to "hold by the hand" the parties responsible for maintenance and encourage and guide them along those paths which we feel should be trod in order to minimize this expense.

People are not interested in maintenance as such. They become interested in maintenance only when the lack of proper care results in a stoppage of production. Maintenance of welding equipment is very important and we feel that the minimizing of maintenance expense is desirable. We feel that the advent of good quality in maintenance will result in greater production, better quality of work and decreased total costs.

There are several points which should be considered in the program of maintenance reduction. One of the first points, possibly the most important, is the proper selection of maintenance personnel. With resistance welding equipment we have a peculiar combination of mechanical features, electrical circuits (both control and power) and air or hydraulic operation to achieve the necessary pressures for the process. The combination of these various factors results in considerable difficulty in the selection of personnel who are capable of adequately controlling these diverse systems.

My experiences in the field have indicated that most of the best maintenance men are those who have had a basic electrical training on which has been superimposed a good mechanical experience and training. It appears that there is some difficulty in getting a good mechanic to become interested in electrical control circuits and electronics, whereas the opposite is not true. The man that is interested in electronics can become adept in mechanical maintenance and he does not seem to have difficulty in gaining the required mechanical "know how."

We suggest that a resistance welder maintenance man be responsible for the complete equipment: the electrical mechanical, hydraulic and pneumatic systems; back to the main supply valves or switches. If he requires specialized assistance in electronics, he can call in an electronic engineer to asist him in that. If he needs a plumber or mechanical help, he calls in assistance from the other shop groups. But fundamentally, he should be responsible for the entire equipment back to the main connection valves or plant supply line. This procedure will eliminate the necessity for calling in other groups for routine maintenance work and will avoid some confusion with different labor groups.

I realize that may not be possible under all plant situations, but it has worked out very well at companies where I have observed this practice. A considerable portion of my field experience was derived in aircraft plants during the war, in the processing of aluminum sheet. In those particular installations, we necessarily had a very complex electrical circuit associated with the welding machines, and the electronic maintenance was high. However, when we speak of an "average welding machine" at the present time, we cannot say that the electrical control maintenance is a very considerable factor.

Observations have indicated that the required maintenance of different portions of the machines themselves can be broken down in approximately the following percentages: I would evaluate the machine maintenance itself, including the air and hydraulic control, the transformer and secondary circuit, at about 20% of the total maintenance of the equipment. To electrical controls I would assign about 10% of the total maintenance. The fixturing equipment for holding alignment of various welded parts requires about 20%, leaving the heart of the welding equipment—the welding electrodes—bearing about 50% of the toal maintenance of the equipment.

This is no reflection upon the electrode materials which are in use. It is merely a characteristic of resistance

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* One of three talks on "Maintenance of Welding Equipment," before the Detroit Section of A.W.S., Jan. 9, 1948.

† Progressive Welder Co., Detroit 12, Mich.

welding equipment. Welding electrodes have to take a lot of abuse, mechanically, electrically and thermally. The electrode materials which we have today are good and, when properly used in conjunction with proper welding equipment, we can obtain reasonable maintenance, but it is still going to be close to 50% of the total maintenance of the equipment. We have different types of machines in different plants. Concerning flash welding machines, control maintenance is practically nil, but mechanical maintenance will approach 50%.

When we have multiple spot and special machines, such as we have in abundance here in Detroit, the electrode maintenance is going to be high as indicated. The associated cables going to the multitude of electrodes are also expendable items and it will be necessary to replace them frequently.

However, getting back to the reduction of maintenance expense; after we have selected and trained this personnel, we should devote attention to the purchase of well-engineered welding equipment. By well-engineered welding equipment, I do not mean equipment which is modernistic or streamlined. I mean equipment where the welding components are so placed that those components requiring maintenance are available for inspection and adjustment. This is not always the case, sometimes necessarily so because of the required design of the equipment. For the large panels which we spot weld on multiple electrode machines in Detroit, the so-called series welding system is in quite common usage, wherein the welding current goes down one electrode and up the next electrode, back to the welding transformer. This results in a low-cost machine, but it also results in very high electrode maintenance because of the shunting currents required across the top sheet which do not assist in making the weld itself, but which do contribute to electrode heating.

In a number of cases it would therefore be desirable to use more expensive welding equipment which would utilize direct welding means and eliminate the excessive shunting current and the higher electrode maintenance accruing from that system of welding.

Control equipment on welding machines should be, if possible, located so that maintenance can be easily accomplished. Control boxes should not be at the floor where an electrician has to kneel or lie down on the floor in order to do the maintenance work. Elevated controls also insure that there will be no water, chips or dirt brushed into this control cabinet during floor or machine cleaning. The electric and pneumatic or hydraulic control should be separated as much as possible, so that it will not be necessary for a pipe fitter or mechanic to work in positions where he may accidentally come in contact with electric circuits which are energized.

In the purchase of special welding equipment such as multiple electrode machines, care should be taken to insure that no more electrodes are specified in the equipment than are absolutely necessary. A multitude of electrodes always makes difficult the placement of these components so that maintenance can be accomplished easily. Therefore, attempt to use the fewest number of spots possible. Then the machine can be kept simple, adequate pressures and current can be built into this machine and proper electrode maintenance will be obtained.

Proper maintenance and test instrument equipment is very advantageous in improving the quality of the welding results and minimizing maintenance. It is necessary that the maintenance man be capable of using a volt-ohmmeter for checking through his control circuits. He must know how to measure welding pressures, welding currents. It is very desirable, where an equipment is used on a repetitive job, that a tabulation of the various setups on this particular machine be recorded, and that any deviation from a standard setup be an indication of an improper operating condition of this machine. A variation of $\pm 10\%$ in a control setting will normally be sufficient to bring satisfactory welding results. If it is necessary to change the setup of pressure, current or timing by more than 10%, maintenance is required on that equipment.

In order to prevent excessive "down time" of a welding machine, an adequate supply of spare parts must be instantly available. Many machine breakdowns can be prevented by regular inspection to determine the necessity for replacement of various components of the welding machine. This is particularly true in regard to those components whose eminent failure becomes gradually apparent. These items frequently are: air cylinder leathers, valve components, air pressure regulators and hydraulic pressure regulators, machine slides and ways, the welding electrodes themselves, the machine secondary circuit contacts and the transformer tap switch. Many items can be stocked so that they will be available for the maintenance crew.

The necessity for replacement of these items can very easily be determined by periodic inspection of the machine. Transformer tap switches or defective secondary circuits can be checked easily by gaging the temperatures of these units in operation. As copper oxide forms in the joints of the secondary circuit, there will be heating at these joints and any maintenance man can determine the necessity for overhauling of the secondary circuit. The frequency of this operation will depend upon the industrial atmosphere at that particular location. One year should be the maximum interval between successive cleanings of the machine secondary circuit.

There will, of course, be breakdowns of welding equipment which are not anticipated. There seems to be a considerable amount of maintenance associated with welding machine—possibly as much as there is in any equipment of similar cost. Items such as electronic tubes, telephone relays in control circuits, air pressure regulator diaphragms, foot switches and other items of similar nature will be subject to instantaneous breakage or failure.

The equipment will also require lubrication at different points. The pneumatically operated equipments usually have air lubricators which require periodic filling. These lubricate any leathers which are present in the valves or the operating air cylinders. The lubrication may be accomplished by a man qualified to inspect the equipment, but this is normally not the case. Usually, inspection should be by a qualified maintenance man who is in a position to know what conditions are normal on the various equipments.

The quality of the welding job which is coming from a machine is an excellent indication of its operating condition. An examination of the welding results will normally indicate defective operation of the machine and usually indicates the location of that misoperation in the machine.

The cleaning of electrical controls should be accomplished in a gentle manner because the tubes and relays in these control circuits are rather fragile mechanically. The brush type vacuum cleaner suction tube is quite satisfactory for normal maintenance in this respect.

During one of my first field trips about ten years or so ago, I came in contact with the plant electrician who was also in charge of welder operation. He impressed me with one statement and demonstration which he made. He told me that he was not satisfied with any machine setup until it had proved itself by a minimum of electrode maintenance. He proceeded to put across the point that, with proper machine setup, he got good elec-

trode maintenance and that it was not necessary to continually redress and reshape the welding electrodes. He told me that he was not satisfied with a machine setup until he was able, on No. 14 gage material, to produce 1000 spots with that machine before it was necessary to clean or redress the electrodes. This was on material with mill scale, but no rust. He demonstrated that, with variations from this optimum condition, he could produce electrode mushrooming, bad surface burns on the material, or electrode deposit on the material.

So I would like to emphasize that excessive electrode maintenance may be dictated by your machine specifications when you specify an extreme number of electrodes or very close spot spacing on a multiple electrode machine. Give the welder manufacturer a chance to design into that equipment proper electrode pressures and clearances.

There are several points which are a guide to machine adjustment—points which are derived from the appearance of the weld coming from the machine. These comments in general are directed toward the welding of low-carbon steel. We know, of course, that excessive indentation of material indicates that the electrodes are either too small or the current is too high. We may find the same condition causing "spits" or expulsions, but usually these are caused by low electrode pressure. Excessive sheet separation may be caused by poor fitup of the stampings or excessive electrode pressures, particularly in softer alloys. Insufficient penetration (a thin weld nugget) will quite frequently cause a brittle weld—a weld having not sufficient ductility to do the job required. This is usually caused by high-weld current associated with an excessively short welding time. Insufficient squeeze time on the welding guns or the welding machines gives results similar to low electrode pressures.

All welding electrode dies should have replaceable copper alloy inserts so that the cost of servicing the die will not be excessive. In seam welder bearings, the usage of graphite impregnated grease is not as common as a few years back. We have had considerable better bearing and spindle life from the usage of a lubricant which is quite solid at room temperature and fluid at normal seam welder bearing temperatures. The seam welder lubricant is preferably applied every four hours operating times; better yet, every two hours.

There are several common methods of maintaining electrodes, depending on the type of welding equipment and kind of material being welded. Hand or power-operated hollow mills are capable of maintaining a spot-welding electrode in reasonable shape when welding materials where the electrode indentation is not a critical factor. When necessary to have a minimum of electrode marking it is usually desirable to use some sort of dressing paddle with an emery wrapping of 180 to 360 grit number.

The usage of dome-shaped spot-welding electrode faces has become quite prevalent because of the relative ease of maintenance and resulting excellent weld surface appearance.

Electrode alloys in common use have annealing temperatures anywhere from 500 to 900° F. If we go above these temperatures we are going to have rapid deforming of the electrode faces because they have lost a very substantial percentage of their original strength. Electrodes which cannot retain their shape will not produce good welds consistently. An adequate supply of electrode coolant is necessary in order to achieve a minimum of electrode maintenance.

With conscientious effort devoted to the forgoing items a minimum of welder maintenance will be obtained, along with the desired weld quality and low production cost.

Periodic Inspection and Preventive Maintenance of Arc-welding Equipment*

By Volney H. Speck†

MY REMARKS will be confined to the maintenance and care of a.-c. and d.-c. single-operator arc-welding units of the 150, 200, 300, 400 and 600 amp. type most commonly used.

Our maintenance policy in the past has been more or less a policy of "trouble shooting, repair and overhaul." Formerly, when difficulties arose, a welder maintenance man was called to ferret out the trouble and make the necessary adjustments if possible. However, because operation of the unit was continued until the quality of the weld was affected, the condition of the unit usually required its being returned to the repair shop. This meant replacing the unit at least temporarily, loss of production while this was being done, to mention nothing of the quality of the welds made previous to the changeover.

I would like to provide a program of periodic inspection and preventive maintenance which eliminates so many of the welding difficulties experienced in the past that we find it pays huge dividends in quality workmanship, efficient performance of the arc-welding unit, prolonged machine life, spoilage caused by improper welding, changeover time, handling, repair and overhaul costs, etc. The cost of such a program is negligible. It simply means activating that crew of welder maintenance men. Rather than to have them wait for a "trouble" call, have them avoid that trouble through this program of periodic inspection and preventive maintenance.

Normally, welders do not require a great deal of care especially if they have the capacity for the job required, and are properly installed and operated. The "care" part of the program begins with the operator. He should have complete instructions available regarding the proper hookup and operation of the equipment he is to use. He should be provided with the essential welding accessories such as shield, shaded lens, protective clothing, gloves, etc.

Care also should be taken in observing certain fundamentals in the hookup of arc-welding units. Briefly, these can be enumerated as follows:

1. Because of periodic overloads, the fuses in the motor power circuit should be two to three times that of the motor current rating.
2. Units should be well supported and leveled wherever possible.
3. Electrical connections should be clean and tight.
4. Welding cables should be of proper size, well in-

* Presented at January 9, 1948 meeting, Detroit Section A.W.S.
† Chemical & Metallurgical Research Laboratory, Ford Motor Co.

sulated and protected from mechanical hazards such as trucks, cranes, stock, etc.

5. Adequate cooling facilities for the unit should be provided and the motor shut off if the unit is allowed to stand idle for any length of time.

6. Units should *not* be installed where abrasive materials or corrosive vapors might impair their operation. Where this cannot be avoided, proper protective measures should be taken to prevent undue wear and inefficiency.

7. Excessive heat or moisture also are to be guarded against.

8. Units should be properly lubricated to prolong bearing life.

9. Adequate protection such as canopies or shelters should be provided for units operated out-of-doors.

10. Proper eye-bolts for lifting units with cranes, etc., should be installed.

The welder maintenance men should be instructed to check all installations to see that every precaution to safeguard the equipment has been taken.

Periodical inspection of welders is a part of the preventive maintenance program which should be followed religiously. Do not wait until trouble is encountered or an overhaul job is necessary. Inspect units regularly, clean them properly, check brushes, commutators, bearings, windings, insulation, electrical connections, cooling facilities, guards, grease cups, etc. Eliminate the *causes* of poor performance. Eliminate or materially reduce that trouble shooting proposition and keep that unit producing. Where the usual accumulation of dust and dirt is normal, the unit should be vacuum cleaned or blown out with 25 to 30 lb. of compressed air. However, where considerable abrasive material such as cast-iron dust is present, the vacuum cleaning method is recommended and breathers or filters should be installed. The latter, the installation of filters, may be classified as a preventive maintenance measure and has eliminated many costly repair and overhaul jobs. In this connection let me cite our own program of maintenance care and preventive maintenance. We have 193 a.-c. transformers and 326 d.-c. motor generator sets in operation for a total of 519 units. These units are installed in the various buildings comprising the Rouge Plant of the Ford Motor Co. A maintenance schedule has been devised and efficient maintenance and repair crews selected to see that our welding units deliver top performance. In certain buildings such as the Foundry where the effect of the cast iron dust on the welders requires extra care and cleaning, filters have been installed. In fact, filters are being installed as rapidly as possible on all welders throughout the plant. This maintenance crew takes one building at a time according to schedule so that a thorough inspection of all units is completed every thirty days. Units in buildings such as the Foundry Building may require checking every week.

These maintenance and repair crews are thoroughly familiar with what to look for when the more serious troubles arise, how to overcome them and, also of importance, to devise methods of preventing their recurrence. To illustrate a few of the difficulties encountered with motor generator sets which can usually be avoided by a system of Periodic Inspection, let us enumerate some of the more common troubles and the causes for them. Let us suppose when the operator tries to start his unit it will not start. Through experience and his knowledge of the hookup the welder maintenance man starts to systematically check the trouble. First he probably checks the fuses to see if any are blown and if they are of proper size. Next he most likely checks to see if the power circuit is dead. The next step would be to see if there is an open circuit to the starter control and if the power lead is broken. He may find the unit has been overloaded or used constantly for a long period and has heated sufficiently to cause the overload relay to trip. There may be an obstruction in the contactor. Suppose a second unit is in operation but is not delivering the proper current. Probably the brushes will first be checked for wear and to see that they are not loose in the brushholders. Possibly there is an open field circuit, the trouble may be remedied by reversing the leads to change direction of rotation. Suppose an operator complains that his unit will not take the rod he is to use. This may be due to poor connections to electrode holder, electrode cable, ground cable or ground return circuit or it may be that the current setting is too low for that particular electrode. The cables may be too small or too long. If welding spatter is excessive, possibly the current is adjusted too high or the wrong polarity is being used.

These are just a few of the difficulties which may be encountered in production and building maintenance work.

The remedies, in most instances you will agree, are quite simple. Certainly there is nothing that a live wire crew of carefully selected and well-trained welder maintenance men could not control or greatly reduce through a planned schedule of periodic inspection.

Practically nothing has been mentioned so far regarding the care and maintenance of the a.-c. transformer units. Besides keeping electrical connections clean and tight, removing dust, and foreign matter and guarding against overheating, little actual maintenance is required.

There is one more point I should like to call to your attention before closing and that is the growing tendency to disregard the use of proper enclosures or booths as protective measures against the spattering of hot metal and arc flash. The latter can become more disconcerting to those who must work near an arc welder than to the operator himself. These are safety precautions and are just as essential as the operator's face or head shield with its shaded lens or his protective clothing and gloves.

This, my friends, is what I mean by a program of periodic inspection, care, and preventive maintenance. I sincerely urge you to give it a fair trial. I know you will not be backward about going forward.

Seam Weld Attachments for Spot Welders of the Rocker Arm Type

By W. S. Horth*

THE principle of trying to do seam welding on a spot welder raises the question of whether the spot welder has the capacity and whether the characteristics are those required for seam welding. The spot welders in most shops range from 10 to 50 kva. and seam welders range from 50 to 400 kva. The reason why seam welding can be done on as low as 10- to 50-kva. spot welders is the result of the following four factors:

1. The wider the weld or seam the more heat required and vice versa a narrower weld requires less heat than a wide weld. On these attachments we use welding wheels of $^{5}/_{32}$-in. width rim or about one-half the width of rim used on seam weld machines resulting in far less power demand.

2. On the attachment the continuous weld is usually used. Where the power is on continuously the kva. demand is less than if the power is on for, say, 4 cycles and off for 4 cycles.

3. Certain metals take far less power to weld than others. Cold-rolled, pickled annealed and stainless steels are in this class, and they are the principal ones recommended.

4. The heavier gages of steel require more power to seam weld than the lighter gages. On the 100-kva. seam welder #11 gage may be seam welded, by limiting the gage to #18 for the attachment the capacity required is thus correspondingly reduced.

In addition to the above four reasons why seam welding is not only possible but practical on the small spot welder, there is the fact that at slower speeds less heat is required to make a seam weld than at higher speeds. On the small 10-kva. spot welder the highest heat would be required to seam weld two pieces of clean #18 cold-rolled steel with the speed of weld set at 5 ft. per minute. If the speed of welding is now cut back to 3 ft. per minute the heat may be reduced by one or two steps on the heat regulator. The combination of all of these reasons adds up to a great reduction of power required to seam weld, and brings the small, job-shop spot welder into the range required for such work.

Next, the question of whether the characteristics are correct to do seam welding raises two considerations. First, the spot welder is for intermittent duty; if used for continuous duty will it overheat and burn up the transformer? Secondly, will the voltages of the secondary circuit be proper or is it necessary to make some change to get the proper voltage for seam welding?

First, the spot welder should not be used to the full capacity if the continuous weld is used as it would overheat and burn out the transformer. So, to avoid this, consideration should be given to the power demand and the spot welder capacity to avoid this trouble. Using the spot welder on only the lower steps of the spot welder is a good general recommendation for job shops. Where the work is of a very short or intermittent run the spot welder may be used on higher steps. Figuring the power

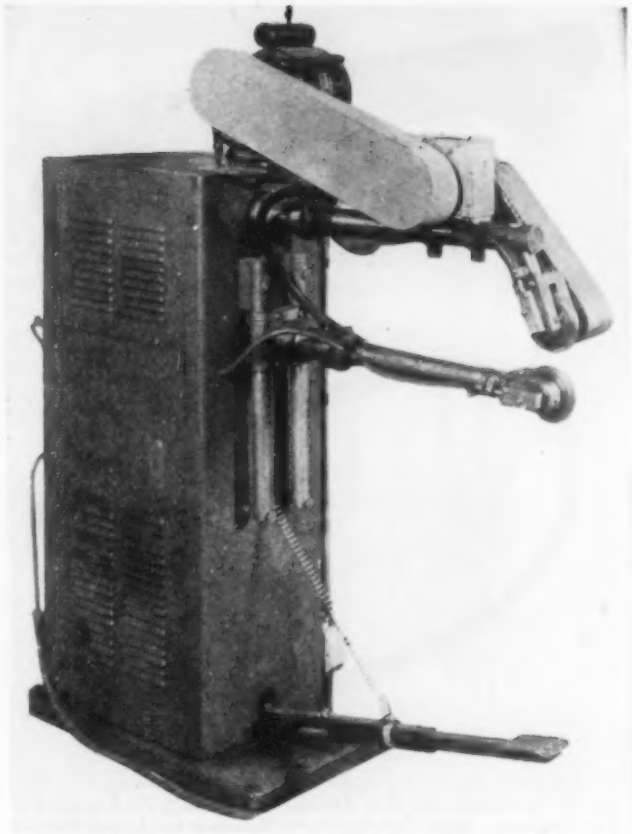

Fig. 1—Parallel Wheel Attachment Mounted on a 20-Kva. Ace Spot Welder, with the Lower Head Put into the End of a Special Arm Supplied with the Unit. Welder Hoses Supply the Fresh Water for Cooling

required and then using a spot welder at least twice that capacity is a fair general rule to follow.

Second, the voltages of spot welders correspond very closely to those for seam welders where interrupted welds are used. But since the continuous weld is the principal weld used and the heat required is less, the voltages in the welders of 30, 40 and 50 kva. become too high for seam weld operations, particularly on the lighter gages. For example, on the side seam of a small stainless steel container of #24 gage it was necessary to put a coil of steel wire around the lower arm to choke down the heat even though the regulator was set on the lowest heat and the welder was a 20-kva. Federal. On the higher capacity spot welders of 30, 40 or 50 kva. rating the minimum gage of metal that can be seam welded gets progressively heavier, where the continuous seam weld is used. Further substantial choking as explained above will help as will the introduction of a separate 2 to 1 auto transformer between the contactor and the transformer of the welder. The use of a seam weld control that can be obtained from control manufacturers in that line will permit interrupted welding and thus reduce the heat applied per inch of weld and allow lighter gages to be run. Where the regular spot weld control is of the electronic type and the tubes have sufficient capacity for the work to be done, a small initiating interrupter may be used to control the main spot weld controller and thus simulate the seam weld controller.

There has been considerable discussion as to the strength and reliability of the continuous weld as compared with the interrupted weld. The general analysis of this is that where the run is of short length of 6 in. or less the continuous weld is quite satisfactory. But on longer runs of a foot or more the heat of the weld progresses ahead of the weld thereby increasing the resistance of the metal and reducing the current. The weld thus becomes

* Electrical Maintenance & Engineering Co., Cleveland 12, Ohio.

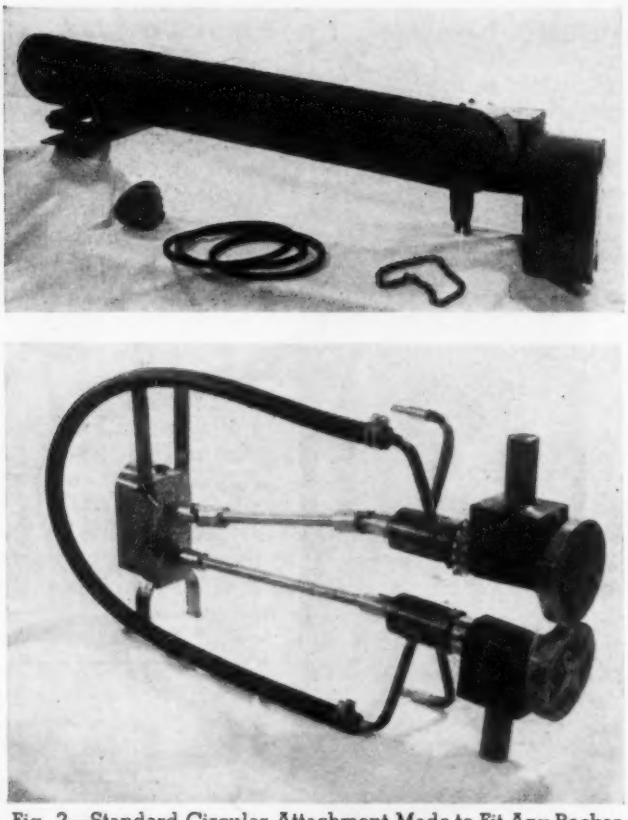

Fig. 2—Standard Circular Attachment Made to Fit Any Rocker Arm Welder. Note Only the Parts Shown in the Lower Picture and the Chain Guard in Front of the Speed Reducer Are Removed When Doing Spot Welding. Welder Hoses Supply the Fresh Water for Cooling

weak and may finally become no weld at all. A more careful analysis of this statement will show the faults or, rather, limitations that should be considered. First, the amount of heat that is involved and the radiating area to dispose of the heat at the weld fixes the temperature and, since the speed of weld in limited by the fact that the wheels cannot get far from the weld until it has set or cooled enough to stick together, the heat involved is the thing that fixes the speed of weld. The less the heat the faster the weld. Likewise the rate of travel of the heat along the metal is a fixed item when the temperatures at the weld and radiating area are known. This rate of travel of the heat ahead of the weld is real when the speed is slow and the metal is cherry hot. However, in light gage metals no color appears on the surface when the weld is made and at 5 ft. per minute. Here the welding is traveling faster than the heat progresses and thus the above general statement does not apply.

No article on the matter of seam welding would be complete without presenting the facts of warping that results from such welding and the analysis of the causes, and remedies or cures.

Cause of Warping.—Running a seam weld makes a line of melted metal that, after solidifying, starts to cool and contract, becoming shorter than the cooler metal on both sides of the weld. This can be compared to taking one thread in a piece of cloth and drawing it up shorter than the adjacent threads.

Results of Warping.—This causes a bow in the stiff longer metal at each side of the weld, so the seam can have a shorter path. In thin metal of longer strips it takes the form of waves. It causes a dishing in or out of the bottom of containers or guards because the rim shrinks.

Remedy or Cure for Warping.—One cure is to hammer, draw or roll the seam to stretch it back to its original length. Fixtures may be made to hold the parts being welded, curved oppositely and equal to the amount of the warp. Then removed immediately after welding while hot, the shrinking brings the part into the desired shape. In some cases rollers or guides may be used in place of fixtures. In 6-in. runs or less the warping is not very marked. Using interrupted spot welding and spacing the spots well apart decreases the warping, and at 2 in. apart the warping disappears. Right angle bends adjacent to the weld, or the rigidity of tubes minimize or make the warping not noticeable. Warping in all cases can be cured and usually at a small expense in equipment and time as the warping is always minor due to the very narrow weld.

The strength of the welds made by this attachment may be indicated by the recent test made by N.A.C.A. on two 6-in. square pillows made by seaming the four edges of 2 pieces of 0.032 Inconel and two pieces of 0.032 stainless steel together using a single seam and $^{5}/_{32}$-in. rim on one wheel against a flat rim on the other wheel. The welds were made on a 10-kva. welder using the top heat at 3 ft. per minute speed. One pillow failed at 1200 psi. pressure and the second at 600 psi. They were blown into round balls before failure. The motor is $^{1}/_{3}$ hp., 1800 rpm. and drives a ball-bearing speed reducer of the double worm gear type of 300 to 1 ratio. The speed reducer is clamped to the top welder arm by copper clamps bolted to steel saddles that are welded to the bottom of the reducer.

The copper welding heads have stems of the correct size to fit into the electrode holes. The heads are copper. The bearings are Mallory #100 Metal. The shafts are Mallory #3 and are lubricated by zerk fittings with graphite grease. The welding wheels are usually Mallory #3 and secured to the shafts by 4 socket-head cap screws, countersunk below the surface of the wheel. On the perpendicular type of wheel the bottom head is driven from a set of back gears that, in turn, are driven from the top welding shaft through universal joints that allow movement of the top welder arm. The top welder shaft is driven by roller chain from a sprocket on the speed reducer. The use of the tilting motor base both allows movement of the top arm where the motor is mounted on a flat top type of welder, and also quick speed change by shifting the belt from step to step on the cone pulleys. Speeds of 3, 4, 5, 7, $8^{1}/_{2}$, 11 and 15 are available, in feet per minute of travel at the weld. A pair of guards are included for the chain and belt drives. After the unit is installed the first time, the motor and speed reducer are permanently left on and only the two heads and back gears are removed when it is desired to use the welder for spot welding. A snap or toggle switch of the double throw, single pole type with off position should be put into the motor circuit. This is thrown to the off position for spot welding, to the on positon on one side for seam welding, and to the on position on the other side for rotation of the welding wheels for dressing when the welding arm is raised. The motor is energized, if single-phase, directly by the closing of the welder contactor, or the control coil of a motor starter is so energized if a three-phase motor is used. Minor adjustments that vary with different controls always permit the power to be kept on continuous as long as the foot is held down on the pedal or floor switch. The weight of the speed reducer and top welding head is counterbalanced or spring balanced on foot-operated welders and on air-operated welders the air takes care of this additional weight.

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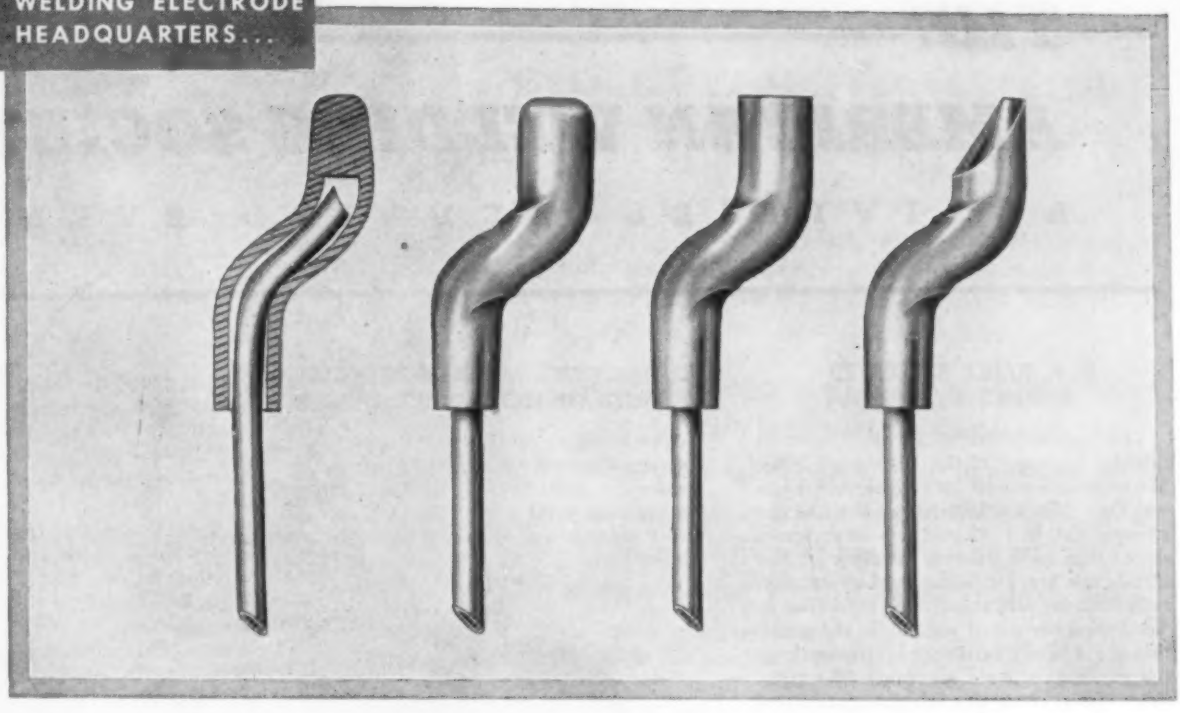

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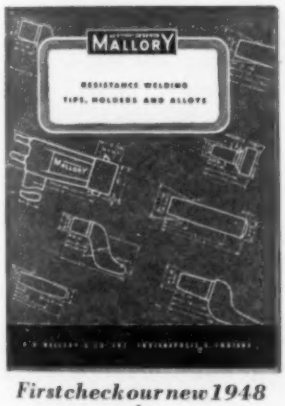

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4. Can be supplied *with* or *without brass water tube.* Brass tube replaces the standard sliding water tube found in all Mallory holders. All electrodes supplied with .245" diameter tubes extending 2" from bottom of electrodes unless otherwise specified.

Send in your requirements. We will welcome the opportunity to supply samples and prices. Mallory is continually developing such improvements as these water-cooled electrodes represent. Mallory investigates life factors of various materials, design, and load carrying capacities of offset holders. Mallory is the only supplier in the field equipped to keep abreast of new developments in its own laboratories.

MALLORY IMPROVEMENTS ARE AT WORK WHEREVER RESISTANCE WELDING IS!

In the United Kingdom, made and sold by MALLORY METALLURGICAL PRODUCTS, LTD. (An Associate Company of Johnson, Matthey & Co., Limited) Hatton Garden, London, E.C.1.

THE PIONEERS OF ELKONITE*, ELKALOY A*, MALLORY 3*, MALLORY 53B and MALLORY 100 METALS.

†*Mallory Patent Pending on Water Cooling Tubes bent in place.*

P. R. MALLORY & CO. Inc.

MALLORY RESISTANCE WELDING MATERIALS

ELECTRODES—HOLDERS—SPECIAL DIES AND FIXTURES—
ELKONITE* METALS—ALLOY ROD AND BAR STOCK—
FORGINGS—CASTINGS—ACCESSORIES *REG. U. S. PAT. OFF.

P. R. MALLORY & CO., Inc., INDIANAPOLIS 6, INDIANA

THE AMERICAN WELDING SOCIETY

ACTIVITIES—RELATED EVENTS

H. E. CABLE APPOINTED DISTRICT MANAGER

The appointment of H. E. Cable as District Manager of the Pittsburgh office has been announced by the Lincoln Electric Co. Mr. Cable came to the Lincoln Electric Co. in 1943 and has been active since then as a welding engineer in the Pittsburgh area. He has worked successfully with the mill and mining industries in developing the use of welding in the maintenance of heavy equipment. His work on the application of the automatic "Lincolnweld" process to the rebuilding of steel mill rolls and mine locomotive wheels has been responsible for large savings in the operations in these fields.

Mr. Cable graduated from Case School of Applied Science in 1929 with a degree in Mechanical Engineering. He was first employed by the Horsburg and Scott Co. of Cleveland. In 1932 he went to Pittsburgh as District Engineer for the National Aluminate Corp., as an industrial water treatment engineer. In 1938 he was transferred to become General Manager of Aluminate Chemicals Ltd., Toronto, Canada, where he continued until entering the welding field with Lincoln.

He is a member of the AMERICAN WELDING SOCIETY, American Chemical Society, American Boilermakers Association and American Society of Mechanics.

LEX APPOINTED ASSISTANT GENERAL MANAGER OF PROGRESSIVE WELDER

Appointment of Joseph R. Lex as Assistant General Manager of Progressive Welder Co., 3050 E. Outer Drive, Detroit, has been announced by John D. Gordon, Vice-President and General Manager of the company.

A graduate of the University of Munich, Germany, Mr. Lex joined Progressive early in 1946, following a broad industrial experience as Plant Manager of Fisher Body Welding Division, General Manager of a Detroit aircraft parts manufacturing firm and as a consulting engineer on production processes and equipment, particularly in the resistance welding field.

Since joining Progressive, Mr. Lex has been active successively in both sales and engineering of the company's line of resistance-welding equipment.

AIR REDUCTION ANNOUNCES SALES DEPARTMENT CHANGES

The former apparatus sales department and the former arc welding sales department have been merged into one department to be known as the equipment sales department, it was recently announced by H. F. Henriques, general sales manager, Air Reduction. Dale D. Spoor becomes manager of the equipment sales department. Ira B. Yates becomes manager of arc welding and supplies sales and J. F. Carroll becomes manager of apparatus sales.

A Massachusetts Institute of Technology graduate with a B.S. in engineering administration, Mr. Spoor entered the oxygen industry in 1928 when he built and operated an oxygen plant at Sacramento, California, for the Western Oxygen Co. In 1929, the Western Oxygen Co. was acquired by Air Reduction and Mr. Spoor transferred to the applied engineering department in New York. In 1933 he went to Philadelphia as technical supervisor, then in 1935 he became a salesman operating out of Washington D. C. Two years later Mr. Spoor returned to New York and was assigned to the general sales department. In 1941 he was appointed manager of Airco's St. Louis district a position he held until 1944 when he returned to New York as manager of the newly formed dealer sales department. He held this position until his recent promotion.

Mr. Yates joined Air Reduction in 1934 and has held various positions in the organization since that time. He became manager of the former arc welding sales department in 1944.

PIPING SYSTEMS

Tube Turns, Inc., Louisville 1, Ky., has just issued a new and enlarged edition of the booklet, "Allowable Working Pressures," which designers, fabricators and users of industrial piping systems will find an important and time-saving reference source.

The booklet gives allowable working pressures for Tube-Turn welding fittings in five classes of piping. The tables are based upon the A.S.M.E. Boiler Construction Code, 1946 edition, and the American Standard Code for Pressure Piping, ASA B31.1, 1942, as revised by supplement No. 2, ASA B31.1b, 1947.

The booklet's subjects deal with piping; gas and air piping (Division 1, within plant or city limits; and Division 2, cross country piping systems), oil piping within refinery limits, oil piping outside refinery limits, and district heating piping.

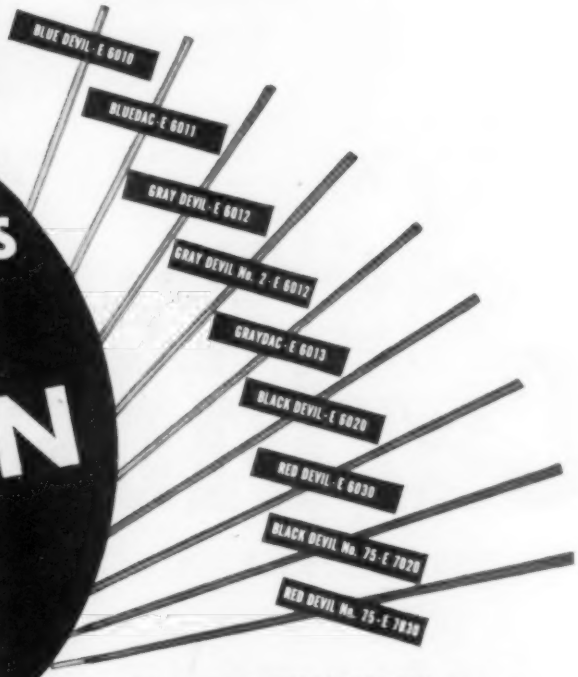
CHAMPION WELDER

GEORGE VEATCH of LANCASTER IRON WORKS, *Lancaster, Pa.*

Says: *"I have been a welder for many years. During that time I have used practically every type of welding electrode. CHAMPIONS are my choice because of their speed, versatility and dependability."*

Try CHAMPION WELDING ELECTRODES on your own jobs and be convinced that what George Veatch and hundreds of other welders say about them is no exaggeration. Like all Champions, they have "what it takes" to win out over competition.

For
CONSISTENTLY OUTSTANDING RESULTS
Use
CHAMPION Welding Electrodes!



A "Team" of CHAMPIONS covers every welding requirement. Send for bulletin describing each electrode and its application.

CHAMPION Electrodes are Weld Rated Electrodes

THE CHAMPION RIVET COMPANY

CLEVELAND, OHIO **EAST CHICAGO, IND.**

BURDETT OXYGEN HAS 25TH ANNIVERSARY PARTY

Celebrating its 25th year of business, the Burdett Oxygen Co. tendered a dinner to 65 employees and associates on February 12th at its main plant in Cleveland.

William H. Loveman, founder and president of Burdett, spoke about the history of the company over the past quarter of a century. He told guests how, in February of 1923, he and five employees opened a small electrolytic oxygen manufacturing plant. Mr. Loveman then traced the growth of the company through the addition of industrial gas manufacturing equipment, plant and warehouse facilities, subsidiary companies and the addition of complete lines of welding supplies under the trade name, "Burdox."

Today, the company has over 200 employees and occupies a manufacturing and warehouse space of over 100,000 sq. ft.

Burdett Oxygen Company's main plant is located at 3300 Lakeside Ave., Cleveland, Ohio.

E. J. Morse, Burdett's Executive Vice-President (Left) Presenting President Wm. H. Loveman with a Combination Clock and Barometer, a Gift from Burdett Employees.

HOW TO KEEP EQUIPMENT ON THE JOB

New Welding Products Bulletin 1047-W, just released by the American Manganese Steel Division of American Brake Shoe Co., Chicago Heights, Ill., is a complete treatise on how to keep equipment of all types operating and producing through Amsco conservation welding. Twenty-eight pages of photographs, drawings and descriptions explain the low-cost method of keeping hard-to-get parts out of the scrap pile by repairing, rebuilding, reclaiming and hardsurfacing with Amsco welding rods and electrodes.

Wherever equipment parts are handling the tough jobs, Bulletin 1047 will provide a formula for successfully waging the war on wear. Numerous examples are given where Amsco Conservation Welding has stretched the service life of parts two, three, five and more times at a fraction of replacement costs.

Complete characteristics and specifications are given for each rod or electrode as well as ingenious shortcuts that have solved problems for typical equipment users. A handy alphabetical reference index is provided which shows, for each major field, the exact rod to use for any specific application.

National

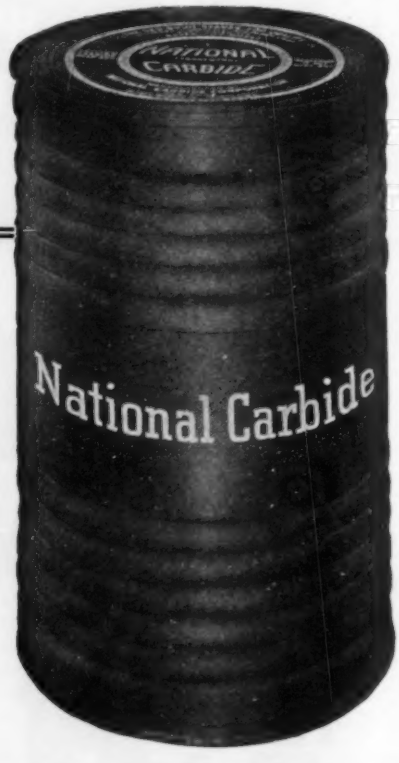
Carbide

IN THE RED DRUM

EFFICIENT

ECONOMICAL

DEPENDABLE



FOR WELDING and CUTTING

Use National Carbide in the Red Drum

Write us for information as to nearest available stock.

60 E. 42nd St. NATIONAL CARBIDE CORPORATION New York 17, N. Y.

Worn Out?

not with NI-ROD in the shop!

Badly worn cast-iron cam. The first beads of Ni-Rod have been laid.

The problem: When this large cast iron cam wore out, it laid up a power shear in the sheet metal plant of McGruer, Fortier, Meyers, Ltd., Montreal, Canada.

Their maintenance men found that the minimum replacement time for the cam would be three weeks. To get the shear back in service sooner, they decided to try repairing.

The solution: The worn camming surfaces were built up with Ni-Rod* and subsequently machined to contour. The Ni-Rod deposit thus formed the new wearing surfaces.

Result? The power shear was back on the job within *3 days* instead of 3 weeks!

This is a *typical* Ni-Rod story — sound, strong, machinable welds in cast iron. Preheating is seldom required. Ni-Rod's easy-to-control arc facilitates cast iron repair work; cuts overhead on tough assignments. It works on both A.C. and D.C.

Check Ni-Rod's superiority in your own shop. Order a 5-lb. package from your nearest INCO distributor. Available in 3/32", 1/8", 5/32" and 3/16" sizes.

*Reg. U. S. Pat. Off.

Worn surfaces have been built up with Ni-Rod.

Cam, after machining. Ni-Rod deposit now forms the wearing surfaces.

THE INTERNATIONAL NICKEL COMPANY, INC., 67 Wall Street, New York 5, N.Y.

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EMBLEM OF SERVICE
INCO NI-ROD
TRADE MARK

SEND FOR FREE INSTRUCTION BOOKLET

J. S. ROSCOE APPOINTED CHICAGO DISTRICT MANAGER

The appointment of J. S. Roscoe as District Manager for the Chicago office has been announced by the Lincoln Electric Co. Mr. Roscoe comes to Chicago

from Pittsburgh where he has been District Manager since 1944. He has been active in the past few years in developing the use of welding in the construction of machinery and heavy mill equipment in the Pittsburgh industries.

Mr. Roscoe came to the Lincoln Electric Co. in 1924 directly from his graduation from Ohio State University. He was made District Manager of the Syracuse office the following year and continued in that capacity until assuming the direction of sales activities for Lincoln in Pittsburgh. Mr. Roscoe is a member of The AMERICAN WELDING SOCIETY.

STAINLESS STEEL PIPING

A new booklet, "Stainless Steel Piping—Why and Where to Use It," deals authoritatively with its subject and makes a welcome addition to the reference libraries of piping engineers. It was written by J. D. Mattimore, chief engineer of the product and research division of Tube Turns, Inc.

Among the subjects covered are: Five major reasons for using stainless steel piping. Types of stainless steels, with a detailed description of Type 304, Type 347 and Type 316, which a survey indicates should serve 95% of industry's requirements. Standardization of pipe and fittings. Selection of pipe joints. Fabrication by welding, with an explanation of the preferred welding processes.

The booklet also contains numerous tables and illustrations.

"Stainless Steel Piping—Why and Where to Use It" may be obtained without charge by writing to: Tube Turns, Inc., 224 East Broadway, Louisville 1, Ky.

CLEANING ALUMINUM PARTS FOR SPOT WELDING

An efficient method of preparing aluminum for spot welding and painting, of protecting finished work against corrosion, and of obtaining smooth, lustrous finishes, is fully discussed in a special feature article appearing in a recent issue of *Oakite News Service*, house publication of Oakite Products, Inc., New York City.

Article describes the production procedures employed in a large eastern plant manufacturing automatic phonographs, where oils, greases, identification marks, fingermarks and oxides must be removed from aluminum parts incorporated in these units before spot welding and painting. Thorough removal of these contaminants from such parts as braces, coin box assemblies, etc., is accomplished by the use of a specialized alkaline material, followed with a deoxidizing treatment which leaves the material in a state of low and uniform resistance, the article reports. Aluminum parts are first tank-dipped in alkaline solution at 180 degrees, followed by a cold running rinse. This operation thoroughly removes oils and greases and leaves a slight etch on the work. Parts are next immersed in a deoxidizing solution to remove stains, oxides and discolorations, and to convert the pieces to proper condition for spot welding. A hot rinse then completes this cycle. After spot welding has taken place, parts are again cleaned and deoxidized to remove new soils and oxides which may have accumulated.

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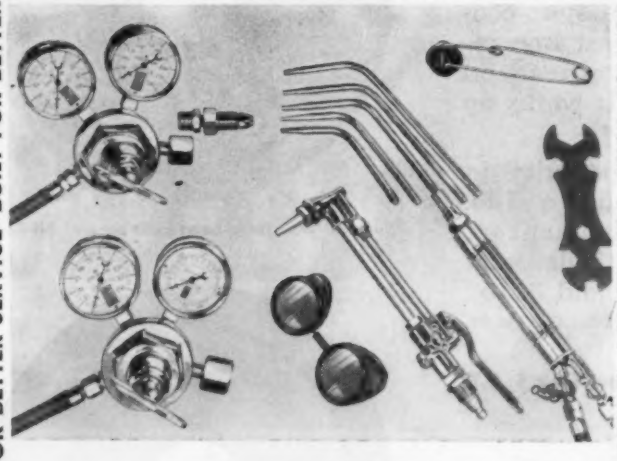

A General Purpose Welding and Cutting Outfit.

DOCKSON'S #145 outfit shown above is vesatile and handy . . . capable of handling almost any light or medium welding or cutting job up to 3-inch steel. The #145 is designed and constructed for long, trouble-free service. Scientifically balanced for effortless operation. • It's a quality kit at low cost.

(Write for welding and safety catalogs.)

DOCKSON CORP. 3839 WABASH • DETROIT 8, MICH.

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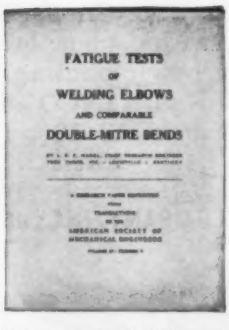
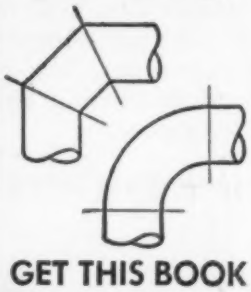
WHICH?

and Why





GET THIS BOOK

Fatigue Tests of Welding Elbows and Comparable Double-Mitre Bends: This research paper gives the authoritative pro-and-con. Analyzes effects of bending in the plane and transverse to the plane of curvature, and bending with and without internal pressure. Mail the coupon.

TUBE-TURN WELDING FITTINGS AND FLANGES

District Offices at New York, Philadelphia, Pittsburgh, Detroit, Chicago, Houston, Tulsa, San Francisco, Los Angeles

TUBE-TURN—T. M. Reg. U. S. Pat. Off.

Tube Turns, Inc., Dept. 4508, Louisville 1, Kentucky
Please send "Fatigue Tests" booklet.

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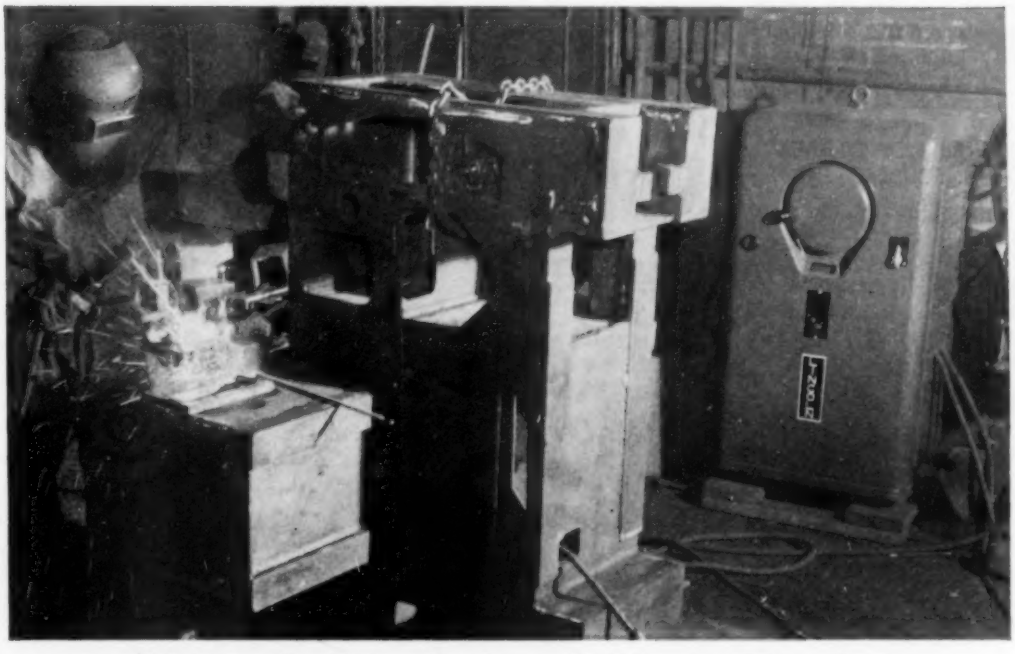
Arc Booster Makes AC Welding Easier

BY GEORGE G. LANDIS, ENGINEERING VICE PRESIDENT
THE LINCOLN ELECTRIC COMPANY, CLEVELAND, OHIO



Fabricating all-welded machine frame with 500 ampere "Fleetwelder."

ARC WELDING with AC welders has been greatly simplified by the Lincoln "Arc Booster." With this exclusive feature, arc striking becomes as simple as lighting a match.

Eliminates Electrode Sticking

The "Arc Booster" control is a simple device which gives the arc a momentary burst of welding current the instant the electrode touches the work, starting the arc automatically. In a fraction of a second after the arc is struck, the welding current returns to the amperage selected for the job.

Increases Safety

The "Fleetwelder" is safe to operate under all conditions. By making possible easy welding with open circuit voltages not exceeding 63 to 70 volts (depending upon the capacity of the welder), the "Arc Booster" eliminates the hazards of high open-circuit voltage or high frequency used in conventional welders to improve arc striking.

Improves Penetration

The instantaneous burst of welding current as the electrode touches the work causes the arc to "dig-into" the parent metal. This improves weld penetration at the start of the bead, particularly important for tack welding or for short beads.

"Arc Booster" Has Job Selector

Any one of six stages of booster current intensity is instantly available with a Job Selector switch, providing accurate control of booster current to suit each welding job. This Job Selector is of special value when changing from thin sheets to heavy plate.

Improves Arc Characteristics

The welder has a reactor type of control which is a free circuit, especially designed for high responsiveness to changing arc conditions. It is separate from the main transformer which is designed for high efficiency. This design gives high arc sensitivity and an exceptionally wide range of output for maximum ease and speed of welding under all conditions.

Reduces Idle Current Consumption

The independent control circuit eliminates the need for high open circuit voltage, contributes to higher power factor. By reducing amount of condensers needed as much as 66%, this new welder minimizes idle current input.

The above is published by LINCOLN ELECTRIC in the interests of progress. Write for free copy of Bulletin 366.
The Lincoln Electric Company, Dept. 104, Cleveland 1, Ohio.

Lastly, prior to final organic finishing, phonograph frames in this plant are given a special, phosphate-type conditioning which passivates surfaces so that if any moisture should penetrate the paint bond, it will not react with the aluminum to cause corrosion products or gas bubbles which would shorten life of paint coats. Readers interested in obtaining full particulars on materials used, solution concentrations, operating temperatures, etc., may secure free copies of the issue of *Oakite News Service* in which this article appears by addressing Oakite Products, Inc., 118 E. Thames St., New York 6, N. Y.

ARC WELDING OF COPPER-BASE ALLOYS DISCUSSED

Ampco Metal, Inc., Milwaukee 4, Wis., has just issued in printed form a paper, entitled, "Arc Welding of Copper and Copper-Base Alloys," given by F. E. Garriott before the Twenty-Eighth Annual Meeting of the AMERICAN WELDING SOCIETY. His discussion covered the arc welding of the copper alloys used most extensively in industry today, such as copper, copper-tin alloys, copper-silicon alloys, copper-zinc alloys and copper-aluminum-iron alloys.

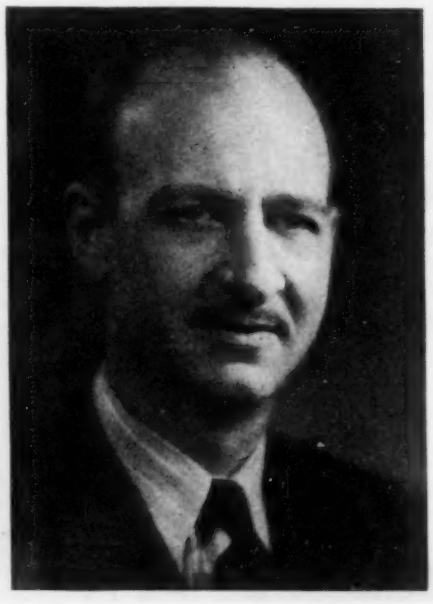
Welding techniques and procedures are discussed at length. Comprehensive tables showing composition and physical properties are given and the bulletin is profusely illustrated with diagrams and halftone views of actual applications.

The subject matter has been authoritatively handled and presents an illuminating picture of the correct use of bronze electrodes.

Copies will be sent on application to Ampco Metal, Inc.

POETHIG HEADS REGO'S RESEARCH DEPARTMENT

For the purpose of providing the welding industry with the best and most up-to-date equipment possible, Bastian-Blessing has greatly expanded its RegO Research Department, so that field contact work may be correlated more closely with the functions and efforts of the company's production, engineering and sales departments.



"Robert E. Poethig will head up this expanded department," announces Mr. E. L. Mills, vice-president of the company. "He brings to this important position a background of experience shared by few men in the entire industry."

Prior to joining Bastian-Blessing, Mr. Poethig headed the sales and engineering departments of a manufacturer of industrial control equipment. Nine years of experience with RegO as field engineer and sales manager, combined with his close contact with the industry itself, have given him outstanding knowledge and understanding of the requirements of the welding industry. Mr. Poethig is a member of the AMERICAN WELDING SOCIETY.

STEEL HOPPER BARGES

To build two 100-ft. welded steel hopper barges and a 60-ft. derrick boat hull for operation on a man-made, land-locked lake near Tulleytown, Pa., Dravo Corp. of Pittsburgh recently constructed a "temporary shipyard" on the lake shore.

The vessels are used by the Warner Co. of Philadelphia, largest producer of sand and gravel in Pennsylvania, in dredging and transporting aggregates on Van Sciver Lake.

Steel for the barges was fabricated at

TIP CLEANING **DRILLS**

Mounted in Knurled

BRASS *Handles*

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LARGE STOCK
PROMPT DELIVERY

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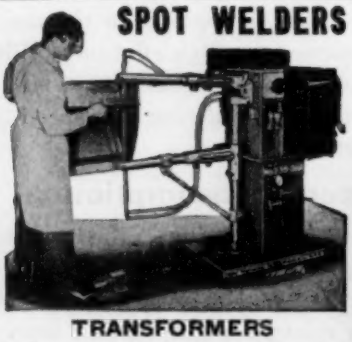
DISTRIBUTORS WANTED

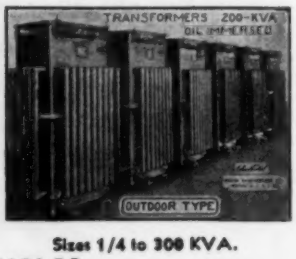
NEW MEXICO STEEL CO.

Box 691, Albuquerque, N. M.

SPOT WELDERS

OF ALL TYPES
SIZES 1/4 TO 300 KVA.
FOR MANUAL, AIR, MOTOR, OR ELECTRONIC OPERATION.
also BUTT, ARC, and GUN WELDERS





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For Furnaces, Lighting, Distribution, Power, Auto Phase Changing Welding, and Special Jobs.
AIR OIL, and WATER COOLED.

Sizes 1/4 to 300 KVA.

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EISLER ENGINEERING CO., INC.
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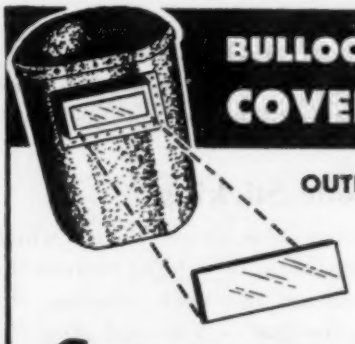

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OUTLAST OTHERS 10 to 1
SPLATTERPROOF
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SEND FOR A TEST BOX OF 10 FOR $1

LIST PRICES
15c EACH
100 for $12.00
500 for $45.00
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Further discounts for larger quantities

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Also 50 mm. Goggle Glasses

Pin a dollar to the coupon and mail it right now. It will save you lots of dollars later. You'll find that Bullock Coated Cover Glasses last 10 to 20 times as long as ordinary cover glasses. Navy Yards and shipbuilders bought Bullock glasses by the millions during the war because they eliminated frequent changes and they produced better welding by improving vision and ending eyestrain.

Bullock Cover Glasses are coated front and back with an amazing waterproof compound that sheds metal splatter, prevents heat-breakage, improves visibility. You ought to be using them... they cost so little! They save so much! Give them a trial.

DEALERS: You ought to be selling them. It's profitable! Write for details.

L. H. BULLOCK CO. 2 EIGHTH ST. RICHMOND CALIF.

Mail this with $1

L. H. BULLOCK CO., 2 Eighth St.
Richmond, Calif.
Send me 10 Bullock Cover Glasses. I'll test them.

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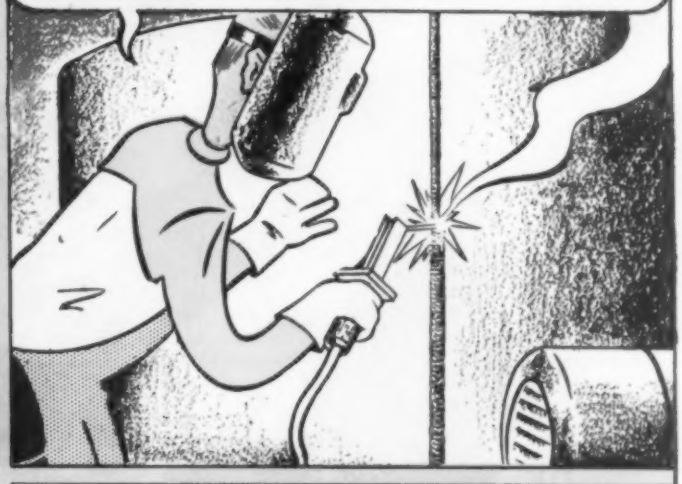
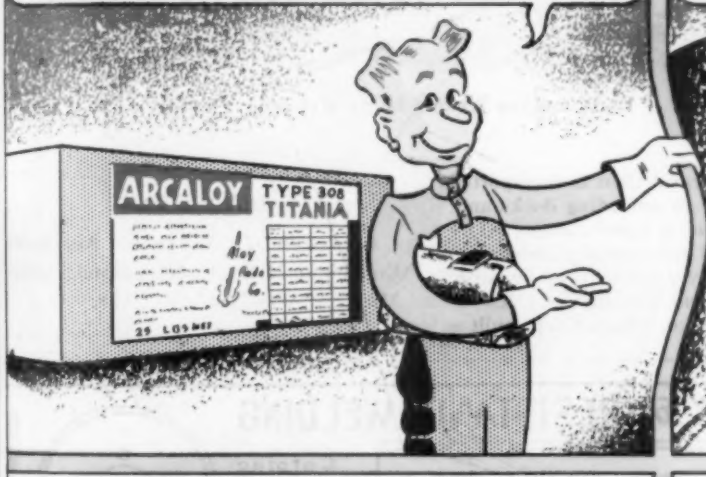
SPARKY "tries all three" ARCALOY coatings

THESE ARE ARCALOY LIME COATING ELECTRODES . . . TOPS FOR STAINLESS STEEL WELDING IN ALL POSITIONS WITH DC.

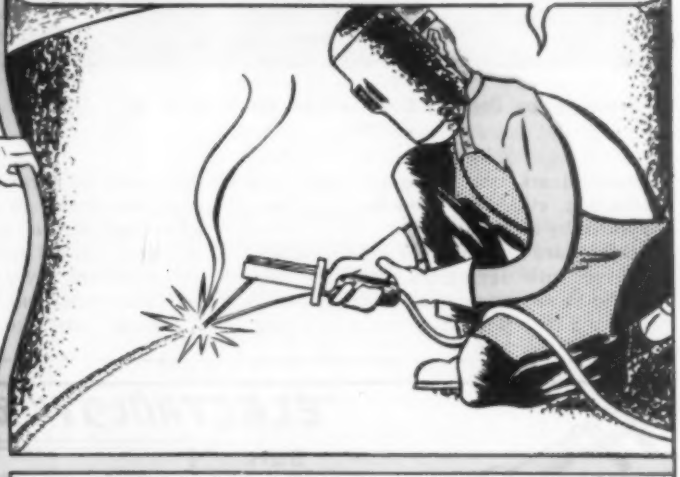
A VERTICAL WELD LIKE THIS IS EASY WITH "LIME". THERE'S NO SLAG INTERFERENCE OR POROSITY, EITHER.



FOR FLAT POSITIONS ON DC, I USE ARCALOY TITANIA COATING ELECTRODES. LOOK AT THOSE SMOOTH CONCAVE FILLETS . . .

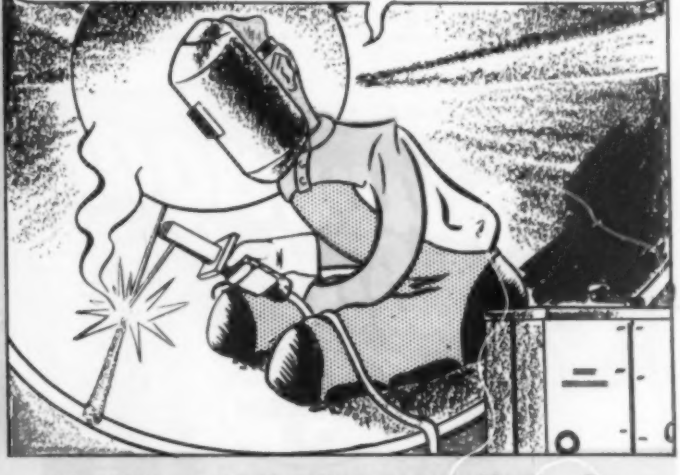


GOSH, THERE'S HARDLY ANY SPATTER AT ALL TO THIS ROD; AND THE SLAG PRACTICALLY COMES OFF BY ITSELF.



HERE'S AN ELECTRODE WITH A COATING ESPECIALLY DESIGNED FOR AC WELDING. IT'S ARCALOY AC-DC . . .

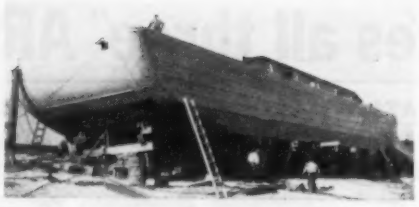
EVEN LOW OPEN CIRCUIT VOLTAGE DOESN'T KEEP THIS ROD FROM STRIKING AN ARC INSTANTLY. IT'S SWELL ON DC, TOO.



For samples, see your distributor or write Alloy Rods Company, York, Pa.

Dravo's Neville Island (Pittsburgh) shipyard and transported by rail to the lake. There, Dravo crews constructed launching ways and assembled the craft by welding the prefabricated sections together.

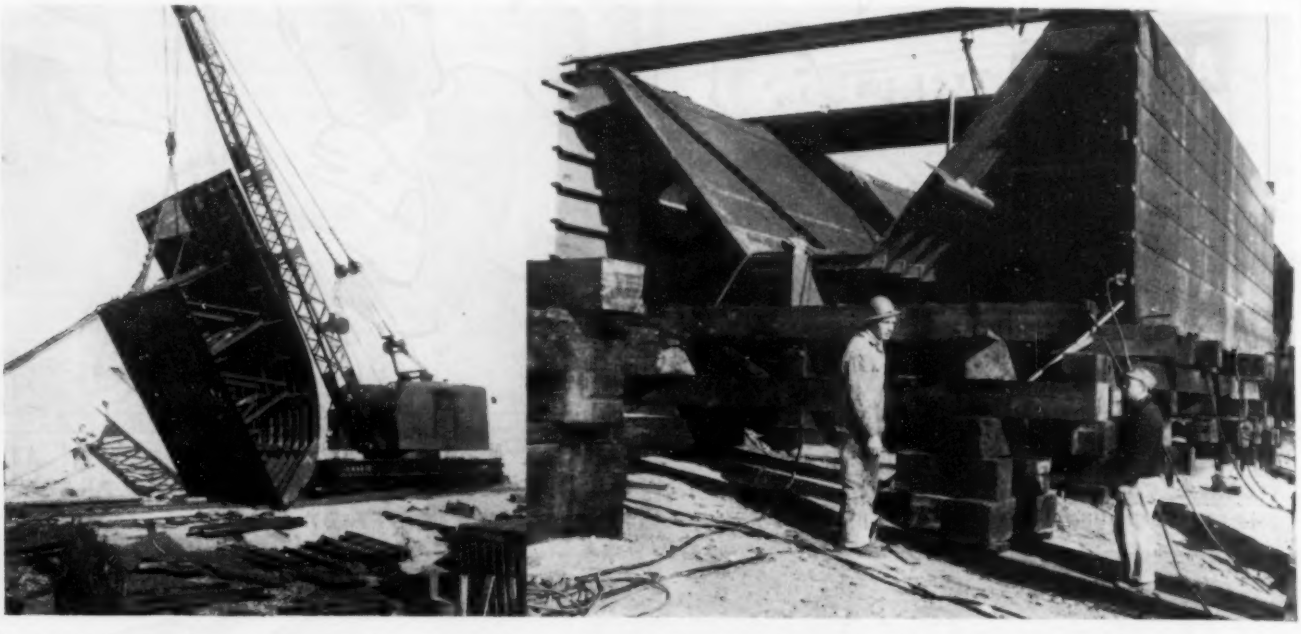
The barges, 24 ft. wide and $10^1/_2$ ft. deep, have rounded and heavily reinforced corners to minimize damage in handling around docks and other craft. The cargo compartments are designed for easy unloading, either by a bucket type conveyor or by cranes.



(Left) "Temporary Shipyard" on the Shores of Land-Locked Van Sciver Lake Constructed by Dravo Corporation to Assemble Two Barges and a Derrick Boat Hull. One Barge Is Shown Just Before Launching

Barges are loaded by Warner's dredge, *Valiant*, with aggregates from the lake which now covers an area of more than 475 acres and represents 25 years of dredging. The sand and gravel then is transported from the dredge to unloading docks and, after classification, is again transported by a Warner-owned and operated railroad to the Delaware River for delivery by barge to Philadelphia and Wilmington, Del.

Several years ago, Dravo Corp. built a floating drydock for Warner Co. on another inland lake in much the same manner as these barges were constructed.

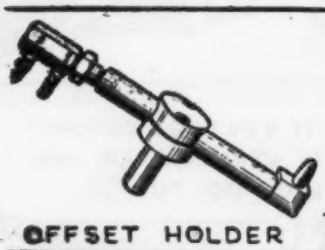


Crane Helps Position Bow Section for One of the Barges

Section of the Welded Barge Welded in Position

IAA MEETING

International Acetylene Association Convention, Book-Cadillac Hotel, Detroit, Mich., May 3rd and 4th, 1948.

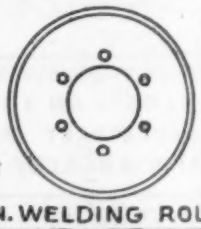


"ELECTROLOY" for RESISTANCE WELDING

Butt
Flash
Spot
Seam
Projection

ELECTROLOY

Catalog and prices on request



OFFSET HOLDER

THE ELECTROLOY CO. INC. 1600 SEAVIEW AVE. BRIDGEPORT, CONN. WELDING ROLL

Time Counts—
Gas cut and Weld with

Shawinigan Carbide

SHAWINIGAN

SHAWINIGAN PRODUCTS CORPORATION
EMPIRE STATE BUILDING, NEW YORK 1, N.Y.

Buy "PROVEN FLUXES"
Years of GUARANTEED SATISFACTION
behind these GOOD
"ANTI-BORAX" FLUXES

Insist on them — Unequalled Quality

No. 1 Cast Iron Welding Flux
No. 2 Brazing Flux for Brass, Bronze, Steel, etc.
No. 4 Braz-Cast Flux for Bronze Welding Cast Iron
No. 5 & 8 Cast & Sheet Aluminum Fluxes
No. 9 Stainless Steel Welding Flux
No. 11 Tinning Compound
No. 16 Silver Solder Paste Flux

Mfg. By
ANTI-BORAX COMPOUND CO., INC.
Fort Wayne, Ind.

YOU SAVE IN 3 WAYS

WITH REVERE No. 456 LOW FUMING BRONZE WELDING ROD

You make important savings at every step of the way when you use Revere No. 456 Bronze Welding Rods for maintenance and repair. Here's how:

1. **FASTER ASSEMBLY**—You save time in assembling the parts to be joined, because the high strength of Revere No. 456 permits wide assembly tolerances and still provides strong, neatly-finished joints.

2. **NO HIGH PRE-HEATS**—You save on the time and fuel costs involved in pre-heating because the low melting point of Revere No. 456 (about 1600° F.) reduces the need for high pre-heats and post-heats.

3. **LESS "CLEAN-UP"**—You save on "clean-up" costs because Revere No. 456 is low fuming and thus enables you to get more accurate placement of the weld metal.

You can use Revere No. 456 for the bronze welding of cast and malleable irons, wrought iron, cast and wrought steel, cast and wrought bronze. Try Revere No. 456 and see for yourself how you can cut costs, save time, and get better results with this "flame-tested" rod in the striking red, white and blue package.

Other Revere Welding Rods are: Revere Bronze 380, Manganese Bronze, Herculoy, Phosphor Bronzes, Brass (Brazing Rod), Silicon Deoxidized Copper and Electrolytic Copper. All come in 100-pound cases or in 25-pound cartons, net weight, and are stocked by Revere Welding Rod Distributors in all parts of the country. Write for folder giving technical data and net prices.

REVERE

COPPER AND BRASS INCORPORATED

Founded by Paul Revere in 1801

230 Park Avenue, New York 17, New York

• • •

Mills: Baltimore, Md.; Chicago, Ill.; Detroit, Mich.; New Bedford, Mass.; Rome, N. Y.

Sales Offices in Principal Cities, Distributors Everywhere.

NEW PRODUCTS

The Society assumes no responsibility for the validity of claims in this section

COWHIDE WELDING GLOVES

The Air Reduction Sales Co. has announced the addition of chrome tanned cowhide welding gloves to its complete line of welding supplies and equipment.

According to the manufacturer, these gloves meet the demand for a durable, low-priced welding glove.

The new gloves are made of medium weight, chrome tanned cowhide with a one-piece leather back employing the wing-type thumb construction and fabric lined cuff.

The wing-type thumb allows maximum thumb action without binding or pulling across the palm. The sturdy fabric cuff lining prevents sagging or crumbling of the cuff section. In addition to these advantages, exposed seams across the back of the glove have been eliminated thereby minimizing the possibility of cuff separation. This feature alone should appreciably increase the "work-life" of the glove.

The new Airco chrome tanned cowhide welding gloves qualify for use with either oxyacetylene or electric arc welding.

For further information on these new gloves, designated as Style 804, write Dept. 1727P Air Reduction Sales Co., 60 E. 42nd St., New York 17, N. Y., or the Airco sales office, retail store or authorized dealer nearest you.

ELECTRODES FOR WELDING CAST IRON

Two new Flexarc electrodes for d.-c. or a.-c. welding of cast iron are announced by Westinghouse Electric Corp. These electrodes—Castingweld and Freemachineweld—were developed to hold thermal stresses to a minimum and to prevent extreme hardness in the heat-affected zone, a condition usually encountered when welding cast iron.

Castingweld uses a mild steel core wire and a special low melting point coating that overcomes difficulties with entrapped slag so frequently encountered in cast-iron welding. The deposit is relatively hard and therefore not machinable. It is available in $^{5}/_{32}$-, $^{1}/_{8}$- and $^{5}/_{32}$-in. diameter.

Freemachineweld uses a pure nickel core wire and is extruded with a special coating adopted for use on cast iron. Using a nickel core wire assists in controlling the welding stresses as the melting temperature of nickel is relatively low and its expansion and contraction more closely match those of cast iron. The weld is soft and readily machinable. It is available in $^{1}/_{8}$- and $^{5}/_{32}$-in. diameters.

Further information on the Flexarc Castingweld and Freemachineweld electrodes may be secured from the Westinghouse Electric Corp., P. O. Box 868, Pittsburgh 30, Pa.

15-KVA. SPOT WELDER

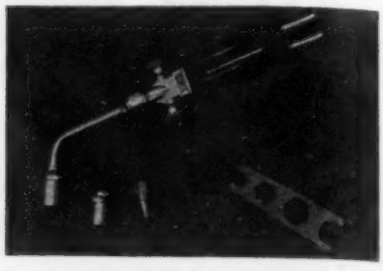
Typical of the many advantages of Banner Spot Welders is the unique head construction of the unit shown. A steel guide through cylinder wall and piston prevents side play of head and assures clean uniform welds. Designed and built by Banner Products Co., 4961 N. 29th St., Milwaukee, Wis., the 15-kva. air-operated welder has other outstanding features as: rugged aluminum-bronze piston with long bearing surface, and three cast-iron piston rings which reduce friction to a minimum. All castings are of high conductivity, high-strength copper alloy. Water manifold is conveniently located on outside of frame—designed for parallel cooling of transformer and electrode holders. Unit is floor mounted. Further information is available. Write for illustrated booklet "Banner Welders and Brazers."

NEW TORCH USES MANY FUEL GASES WITH EITHER AIR OR OXYGEN

Jewelers, dental laboratory technicians, hobbyists and anyone interested in light brazing or soldering operations will welcome the new Victor Model 3401 "four-in-one" torch.

This handy torch can be used with any practical fuel gas such as acetylene, natural gas, city gas or liquefied petroleum gas in combination with compressed air or oxygen. It produces an ideal flame for many operations and is well balanced for sure control during delicate heating jobs.

The molded plastic handle is shaped to comfortably fit the hand. Needle valves are conveniently located for finger tip control and the parallel grip may be easily clamped in a small vise or special



fixtures. The torch is furnished with three tips and a 4-way wrench.

Here is a small torch which has been engineered for the small heating jobs and possesses the quality associated with all Victor apparatus.

WELDING CURTAINS

Welding curtains designed to confine the welding operation to a given area and protect other workers and passers-by from the harmful direct and reflected rays given off by the welding operation also serve as a protecting shield against flying chips and scale when cleaning is being performed.

They are constructed of a special flameproof and waterproof canvas, or asbestos. Double row stitching is used on all seams; substantial hem on all four sides; corners reinforced. The workmanship is thorough.

Standard curtains are furnished with eyelets across the top spaced approximately 10 in. apart and with two in each lower corner. They may be suspended on a horizontal rod or pipe support by means of hooks or cord laces, and bottom eyelets allow for rope attachment to pull curtain taut. This provides an easy means of pulling curtain out of the way when space is to be cleared or for taking work in or out.

Industrial Products Co., 2820 N. Fourth St., Philadelphia, Pa.

RESISTANCE WELDING HOLDER

A new leak-proof, ejector type, light duty holder design has just been announced by P. R. Mallory & Company of Indianapolis. The holder is arranged so that the water circuit forces water against the head of the electrode tip regardless of length, and the water circuit is sealed so that there is no leakage to create a rust problem on the work.

Tip removal is simplified and tip damage minimized by the use of an ejector plug. The complete holder barrel is made of Mallory No. 3 Metal, an alloy having high electrical conductivity and physical strength. It is stated that the use of this metal insures longer life in rough service.

In announcing this new product, P. R. Mallory & Company restate their willingness to offer recommendations on the subjects of electrode metals, tips, holders and dies for the resistance welding industry. Inquiries should be directed to P. R. Mallory & Co., Inc., Indianapolis 6, Ind.

USE ARC WELDING TO MAKE CLEAN, STRONG WELDS IN ALUMINUM

You get strong, smooth seams when you weld Alcoa Aluminum by the new argon-shielded, tungsten arc method. No flux is used; there is no danger of blowholes and slag in the weld. And you don't need to wire-brush or scrub the welded seams afterwards.

Standard machines are used on aluminum with only minor adjustments in equipment and techniques. Good welders quickly learn to make specification welds in Alcoa Aluminum by this process. And Alcoa's technical advice and booklet can speed the learning.

BOOKS... MOVIES... TO SHOW YOU HOW

Write today for a copy of the 128-page technical manual, "Welding and Brazing Alcoa Aluminum".

Three *sound* movies, in 16-mm. and 35-mm. widths, will be loaned to you for showing on your sound projector. Ask the nearby Alcoa sales office. The movies are "Torch Welding", "Arc Welding", and "Resistance Welding". Write to ALUMINUM COMPANY OF AMERICA, 1933 Gulf Bldg., Pittsburgh 19, Pa., or to one of the 54 Alcoa sales offices near you.

ALCOA FIRST IN **ALUMINUM**

ALCOA ALUMINUM 1888 1948 60 YEARS OF SERVICE

NEW HI-FREQUENCY UNIT FOR ARC WELDERS

A new high-frequency unit that attaches to electric welders has recently been introduced by TRI-ARC Corp., Chicago manufacturers of electric welding equipment.

The new unit known as "Pilot-Arc" attaches to a.-c. or d.-c. welders, and is said to provide an automatic arc that eliminates the "scratching" method. Because of the extra impulses it superimposes a more constant flow of current is assured to provide greater welding ease and more positive control of the arc. Simplifies overhead welding and reduces the difficulties of welding light-gage metals and different alloys. Permits the use of any type of electrode, bare or coated.

The Standard Model Pilot-Arc operates from 0 to 300 amp., primary volt a.-c., 50–60 cycles, single phase. Other models for 110-v. or 440-v. and for 0 to 600 amp. are also available.

For complete details and prices write TRI-ARC Corp., 6859 South Anthony Ave., Chicago 37, Ill.

TWO NEW 24-CHANNEL STRAIN GAGE INSTRUMENTS

The Anderson-Fluke Model 301 Strainmeter and Model 302 Bridge Balancer have been developed for convenient and rapid reading of strains in multiple wire resistance strain gage test arrangements.

The Model 301 Strainmeter is a direct-indicating instrument based on null balance of a simple d.-c. Wheatstone Bridge Circuit. A dry cell battery and a galvanometer are the only additional items required to make wire resistance gage measurements with this strainmeter.

The Model 302 Bridge Balancer was developed for selective switching and zero load balance with present type single channel strain indicators.

Capable of accommodating 24 strain gages of the wire-resistance type, these instruments eliminate the necessity for disconnecting and reconnecting gage wires for multiple-gage tests. Moreover, separate zero load readings for each gage can be dispensed with by using the zero load bridge balancers built into these instruments.

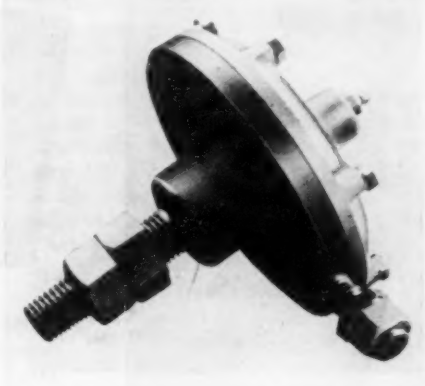
Rapid selection of the gage to be measured is made by a 24-point selector switch mounted on the front panel. This switch has heavy silver contacts, insuring accuracy of successive strain readings.

ROTATING WELDING CONTACTOR

Black, Sivalls & Bryson, Inc., 720 Delaware, Kansas City 6, Mo., announces its intention to mass-produce a rotating welding contactor which has been in use in the company's own plants for several years.

The decision to manufacture the contactor for the welding industry came about after successful operation tests conducted by manufacturers of welding equipment.

The copper rotating contactor and bronze stationary contactor are held together by a spring loaded ball-thrust bearing. A cast aluminum bonnet is bolted to the stationary contactor and seals the unit, excluding dirt and foreign material. The bonnet is provided with a grease fitting so that the unit may be lubricated. Any electrical contactor grease may be used.



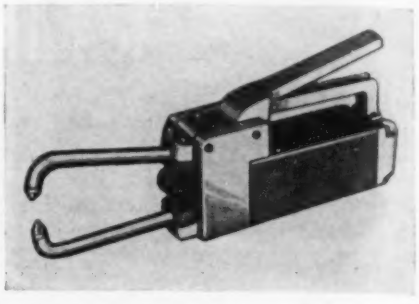
The rotating contactor is provided with a $^{7}/_{8}$-in. threaded bronze stem to which the welding work is fastened. The ground cable is bolted to the stationary contactor by a $^{5}/_{8}$-in. steel stud.

Specific advantages of the rotating welding contactor are: First, it prevents the ground cables from twisting and snarling; second, it does not overheat; third, its minimum of moving parts gives easy, trouble-free operation; fourth, owing to the high load capacity of the rotating contactor, it is well suited for use with automatic welding machines using high currents. Its rating is better than 4-0 cable.

Still another advantage of the rotating contactor is its correct use in pairs on the ends of cylindrical weldments. Used in this manner, the contactor tends to eliminate magnetic interference, which otherwise can cause an imperfect weld.

PORTABLE SPOT WELDER

An entirely different, portable spot welder has been announced by the Miller Electric Manufacturing Co. of Appleton, Wis.



This new self-contained unit, compact and light in weight (23 lb.) will weld up to $^{1}/_{8}$-in. metal, combined thickness. Replaceable tips and tongs available in 6-, 12- and 18-in. lengths enable the welder to reach the hard-to-get-at corners beyond the scope of the conventional spot welder—a time and money saver for any job. Tongs for special applications will be built on request.

Available for use on either 110-v. or 220-v. a.-c. lines, these units are at home in either the small shop or on a large operation.

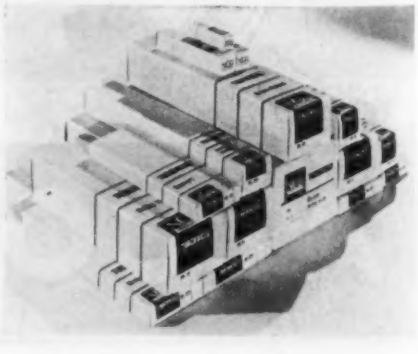
Illustrative literature, completely describing and pricing these units, is now available.

TORCHWELD PACKAGING

Every item in the National Cylinder Gas Company's famed Torchweld line of oxy-acetylene welding and cutting apparatus now bears a "family resemblance" in its package was well as in its name.

Using the familiar "NCG-Everything for Welding" trademark and yellow-and-black color scheme, the company has developed a new line of packages, many of which are shown below, featuring a modern design that will make every piece of its Torchweld equipment immediately recognizable.

From the tiniest tip through goosenecks and holders to the largest torch regulator outfit, every piece of equipment in the line has a specially designed package carrying out the over-all line design. Each package features five elements, color,



"better quality less maintenance"

welding

Spot welding the frame of a James Graham Mfg. Co. Wedgewood Gas Range

Apparatus Dept., Sec. A645-45
General Electric Company
Schenectady 5, N. Y.

Please send me the following bulletins:

- ☐ The Importance of Control, GEA-4571
- ☐ Synchronous Control for Spot and Projection Welding, GEA-4699
- ☐ Nonsynchronous Control for Spot and Projection Welding, GEA-4726

NAME .....

COMPANY .....

ADDRESS .....

CITY ..... STATE .....

GENERAL ELECTRIC

the name of the line, the identification of the piece of equipment, its number and a reverse panel with the trademark and a repeat of the name of the line and piece of equipment.

CARBON ARC TORCH

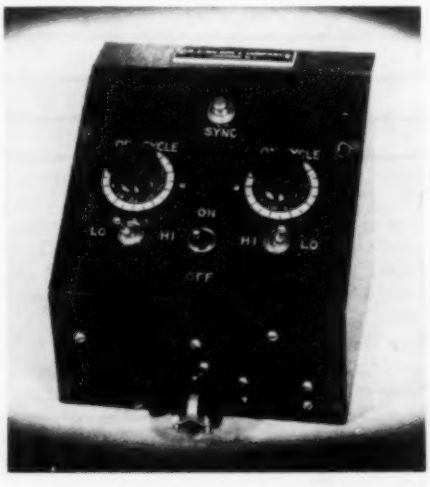
The Lincoln Electric Co. announces a new low price carbon arc torch for use with a.-c. welding machines. The torch is of rugged yet lightweight construction, designed to extend the use of welding equipment to jobs where the application of heat is desired without melting the metal being worked on.

With the arc torch a high-temperature flame is produced between two copper-coated carbon electrodes clamped in aluminum alloy jaws. Both carbons are readily adjustable, geared to move together so that the angle of the carbons can be kept constant at all times. The handle of the torch is provided with simple thumb control tabs geared so that a slight movement of the thumb adjusts the distance between the carbons. To operate, the carbons are brought together to produce the arc, then the proper flame is automatically obtained by reversing one of the thumb tabs until the gears lock.

The unique carbon holder jaws will hold tightly either a $^5/_{16}$- or $^3/_8$-in. diameter carbon without adapters or special extra jaws. The torch is equipped with two cable leads. One lead has a tip that is clamped to the welder's regular electrode holder, and the other lead has a spring clip that clips to the welder's ground lead. The handle is made of rugged thermal plastic. With an a.-c. welder the arc torch can be used for all types of brazing and soldering work, general heating, as well as hard surfacing of thin materials. The torch is suitable for both production and maintenance work: for soldering light or heavy copper, tinned or galvanized parts; for preheating small work areas prior to welding; heating and straightening bent work; brazing cast iron, monel metal, aluminum sheet and castings; for fusing the powder type of hard surfacing material to thin metals; for such odd jobs as applying heat to loosen rusted nuts.

REPEAT CYCLE TIMER

This timer is an electronic device employing one radio-type vacuum tube and obtains its timing intervals by the discharge of two resistance-capacitance combinations in which the resistances are independently variable over wide ranges. Operation is such that one cycle initiates the next cycle without any mechanical parts or external operation. The off and on cycles are independently variable and unaffected by ordinary line voltage changes. A push button is provided for synchronizing the timer cycle with external equipment with which it may be associated.



The timer finds application widely in industrial as well as laboratory use for such varied services as reflux take-off, camera exposure, injection molding, welding, laboratory life testing, etc. It is quite flexible permitting its wide application.

It is manufactured by G. C. Wilson & Co., Chatham, N. J.

SPECIAL NEEDS OF RF HEATING MET BY NEW MACHLETT TUBES

For the first time in the RF heating field the special needs of the electron tubes used in industry have been recognized by a tube manufacturer, Machlett Laboratories, Inc , where the development of five new tubes designed primarily for industrial service was disclosed.

To meet the severe physical conditions imposed by most RF heating operations the electron tube designers introduced heavier metal sections, sturdier anodes, grids, cathodes and terminals thus giving the new RF heating tubes a degree of mechanical strength equal to that of the equipment and machinery with which they are associated.

In addition, the electrical and heat-dissipating characteristics have been so adjusted that the tubes can stand swift changes from no load to full load and back again without injury. In brief, they can handle severe load mis-matching without shortening their life or impairing their performance.

Fig. 1—The Automatic Seal Water Jacket Recently Developed by Machlett Laboratories, Inc., with Its New Line of RF Heating Tubes. No Tools Are Needed to Open or Close the Jacket, Just a Single Twist of the Wrist

The present new line, now available, consists of five new tubes for use in equipment of from 5 to 50 kw. rating, offered for both initial installation and for replacement purposes. Four of them can be had in both air- and water-cooled types; the fifth is water-cooled only.

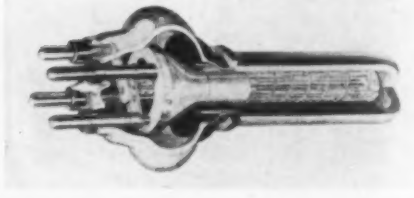


Fig. 2—Sectional View of the New ML-5604 RF Heating Tube, Specially Designed by Machlett Laboratories, Inc., to Meet the Severe Conditions That Obtain in This Type of Heating Service

An added feature of these new tubes, the first to be specially designed for all induction and dielectric heating applications, is a greatly improved water jacket, which, its designers maintain, is the first fundamental improvement in water jackets since their initial use with electron tubes.

MACHINE TOOL AND WELDER PRESSURE SWITCH

As a part of their current "Parade of New Designs" the Square D Co. has recently announced a new pressure switch specifically created to meet the needs of the machine tool and welder industries.

Positive quick-make and quick-break action is assured by use of a precision single-pole, double-throw snap switch mechanism. Separated, nonoverlapping normally open and normally closed circuits

for Uniform Performance

To Be Sure, Say Sureweld

NCG is recognized as one of the largest organizations of its kind in the world. It operates 73 manufacturing plants within the United States, offers supply and service by a vast network of hundreds of independent NCG distributors and warehouse stocks. For assured satisfaction in *your* welding and cutting needs . . .

RELY ON NCG

The guesswork is *out* when Sureweld is *in*. Here's an electrode that does it better, faster and easier—*regardless* of the job to be done. That's the basis for the preference of thousands of satisfied Sureweld users . . "Reliably uniform performance." And there is a Sureweld electrode for *every* type of welding application.

Solving tough welding problems comes easily out of NCG's 30 years of growing up with welding in all its phases. That experience is built into every inch of every Sureweld electrode. Result: more speed, easier operation, easier slag removal, lower spatter loss and an excellent bead appearance. These are the points that Sureweld boosters mention most often.

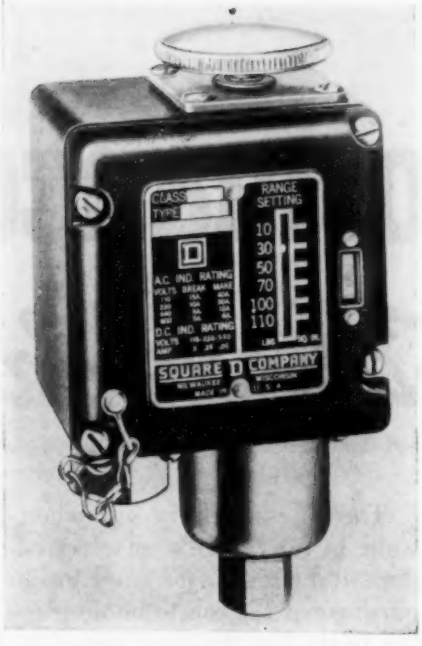
Physical properties of Sureweld electrodes, too, have a reputation for beating standard specifications. Sureweld weld deposits test high in tensile strength, ductility and specific gravity—yet are free of oxides, nitrides and other undesirable inclusions.

You're in for a treat when you use Sureweld electrodes. *Compare!* Call in your NCG representative or distributor and let him *prove* Sureweld's superiority. And remember, *fresh* promptly delivered supplies of Sureweld electrodes are assured you through NCG's nation-wide distribution system.

NATIONAL CYLINDER GAS COMPANY
HOLLUP DIVISION
840 N. Michigan Ave., Chicago 11, Ill

© 1948—NCG Co.

NCG
EVERYTHING FOR WELDING



with double-break silver contacts are provided.

Operating rates up to 300 per minute, without false operation or flutter, have been confirmed by actual operation tests. The snap switch mechanism itself is enclosed in a molded case of noncarbonizing melamine.

Switch enclosures are of die cast aluminum and are drip-tight and oil resistant. Appearance is enhanced by use of recessed mounting holes sealed off by cover gaskets. Exterior mounting lugs or straps have been eliminated.

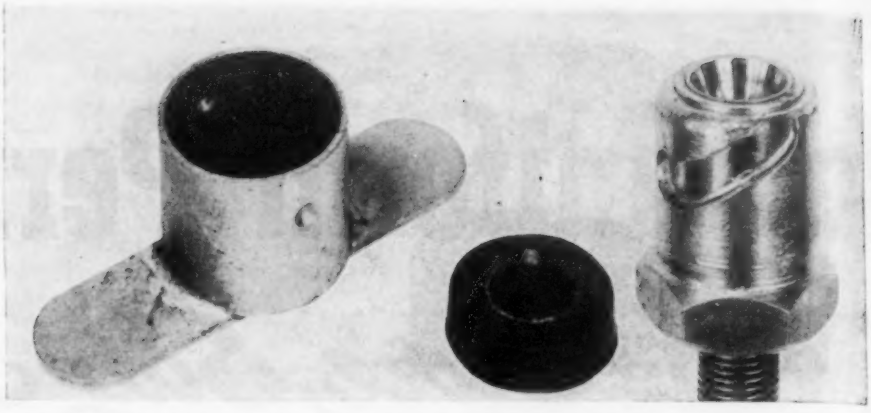
Adjustment of the operating point is made externally using a screwdriver or by means of a convenient adjusting knob which can be furnished.

Bellows-actuated types are available in a variety of ranges up to 1000 psi. Piston-actuated controls for use in the hydraulic field are suitable for pressures up to 3000 psi.

For further information regarding the new Class 9012 Industrial Pressure Switches, write the Square D Co., Industrial Controller Division, 4041 North Richards St., Milwaukee 12, Wis. Request information on their Class 9012 ACW and ADW Types.

UNUSUAL DESIGN FOR BRAZING ASSEMBLY

Included in the "Hydrolock" line of hose connections and accessories manufactured by Acme Aluminum Co., Mansfield Ohio, is an air cap of unusual design. This air cap fits over an adapter which is attached to inflated air bag stems of rubber tires during the curing process. The shell of the cap is a 1-in. length of $1^1/_8$- by 18-in. gage steel tubing, brazed to a flat stamping of 14-gage steel. These components are assembled in a jig and brazed with a gas torch, using a brazing alloy in wire form. Flux is supplied through the torch in vapor form by connecting a vaporized flux supply into the fuel gas line that supplies the torch. The flux is in the flame and the supply is regulated so that no excess or residue is left on the assembly after the brazing operation. Therefore no cleaning of the joint is necessary. The cleanliness of the joint is indicated by the fact that the entire assembly is cadmium plated after brazing without any flux removal whatsoever. The design of the device is such that the only important load on the joint is in torsional shear, wherein the brazed joint works to excellent advantage. Since the tube wall is not heated to the melting point there is no danger of reducing its effective thickness by undercutting, as might occur with a fusion weld of the same design. Two small projections at opposite points in the tube wall engage the helical grooves in the stem adapter to make a bayonet-type connection. A soft rubber plug bearing a split conoid projection is pressed into the shell to form the seat, the split projection serving as a valve.



"Hydrolock" Air Cap and Seat, and Bag Stem Adapter to Which Air Cap Is Attached When in Use

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ELECTRONIC INTERVAL TIMER

Photoswitch Electronic Timer Series 30 is designed for machinery and process control. It has a range of from 0.03 second to 4 minutes. It is recommended for the control of hydraulic presses, chemical feeders, spot welders, grinders, conveyors, drilling machines, photographic printers, and similar equipment.

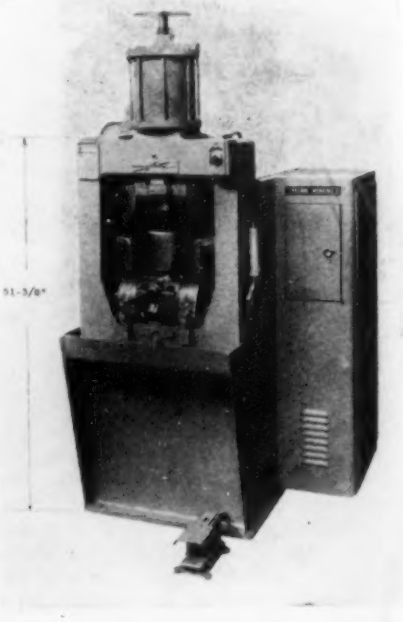
Timer Series 30 provides for all basic types of timing through simple terminal panel connections. This single Timer may be wired to provide interval timing, delayed action, automatic repeat, and programming as well as many variations of these.

Timer Series 30 is recommended when long life and repeat cycle accuracy are the guiding specifications. The unit has a repeat cycle accuracy of 2%. The basic circuit has been carefully designed so that it is self-compensating for changes in line voltage. As a result accuracy does not change from day to day, nor will vacuum tube replacement alter the time setting.

Send for Bulletin PC478, Photoswitch Incorporated, 77 Broadway, Cambridge 42, Mass.

PROJECTION WELDER

Annular projection welds require equal distribution of current around the weld and equalized welding force over the weld area. Higher than normal welding current is required for this type of weld. To keep power demand to a minimum, Taylor-Winfield has designed this highly efficient welder, rated at 150 kva., which delivers 58,000 amp. with the exceptionally low power demand of 348 kva. at 61% power factor while projection welding electrical terminals to refrigerator motor



SQUARE D *Electronic* WELDER CONTROL is designed to INDUSTRIAL STANDARDS

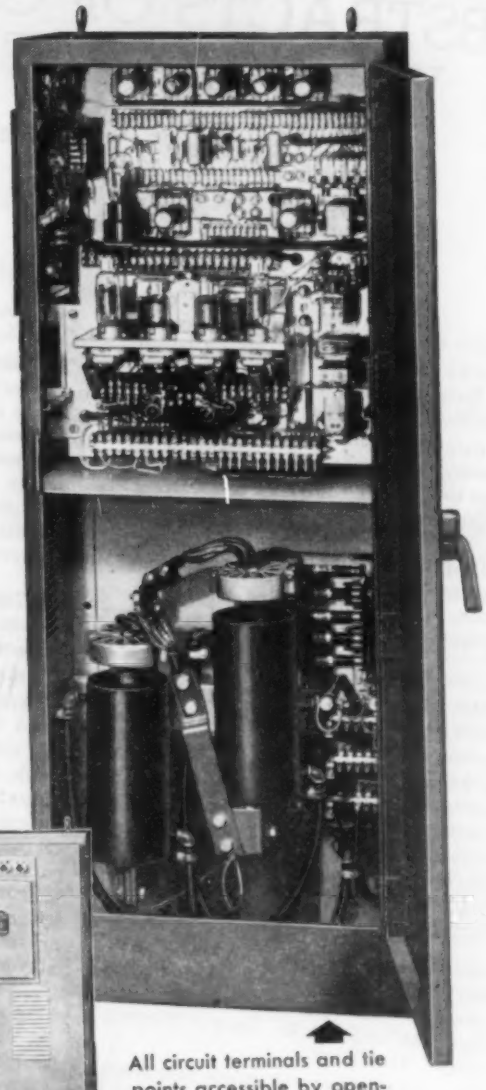
Class 8993 Combination Controllers for Spot Welders Provide Accurate Time and Current Measure Recommended for Welding Non-Ferrous Metals, Stainless Steels, Small Parts and Other Critical Industrial Jobs

ALL FOUR CONTROL ELEMENTS IN ONE ENCLOSURE

- Electronic contactor to carry welder transformer primary current.
- Heat control to adjust welding current from 20% to 100%.
- Synchronous-precision weld timer to control duration of current flow.
- Sequence timer for control of electrode motion.

IMPORTANT NEW CONSTRUCTION FEATURES

- All terminals and circuit tie points completely accessible.
- Each element an interchangeable subpanel.
- Side of machine or wall mounting.
- Screwdriver and pliers only tools required for maintenance.



All circuit terminals and tie points accessible by opening main door and swinging out sequence panel.

IMPORTANT NEW CIRCUIT FEATURES

- Separate excitation of ignitors makes firing independent of load voltage or current.
- Differential discharge timing eliminates voltage errors.
- All-electronic circuit—no sequencing relays.
- Safe—110 volt initiating, no-weld and pressure switch circuits.

Class 8993 controller can be arranged either for side of machine mounting or wall mounting.

Write for Bulletin 208
SQUARE D COMPANY
4041 N. RICHARDS STREET
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DETROIT • MILWAUKEE • LOS ANGELES

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housing cases. Higher electrical efficiency with low power demand is attained through a special divided secondary with a very low impedence. Because of the "box type" frame design, deflection is greatly minimized assuring equalized welding force over the weld area.

This new design of welder has many applications. Considering individual product requirements, such as size and shape, it can be had with rocking—to facilitate loading and unloading—or stationary lower electrode holder. The upper electrode holder is raised and lowered by an air cylinder through heavy-duty guide bearings adequately insulated from the upper electrode.

ABSTRACTS OF CURRENT WELDING PATENTS

Prepared by V. L. Oldham

Printed copies of patents may be obtained for 25¢ from the Commission of Patents, Washington 10, D. C.

2,435,026—Welding Control System—Frederick A. Barnes, inventor, Cleveland Heights, Ohio, assignor to Bailey Meter Co. (18 Claims)

The patented control system has means for moving a plurality of portions of a machine to perform a work operation with a program template controlling these means. A control couple, one portion of which is positioned by the machine and a cooperating portion positioned by the template, is also provided together with time means for controlling the template.

2,435,198—Coated Welding Electrode—Frank E. Browne, inventor, Upper Darby, Pa. (9 Claims)

Browne's patent relates to a coating for a welding electrode wherein the coating comprises soluble alkali silicate, alkaline earth carbonate, cryolite, cerium ore, fluorspar, carbon and at least one element of the class: ferrosilicon, ferromanganese, ferrochromium, ferromolybdenum and manganese.

2,435,494—Platen Drive for Flash Butt Welders—Joseph H. Cooper, inventor, Warren, Ohio, assignor to The Taylor-Winfield Corp., Warren, Ohio. (10 Claims)

This patent relates to an electric flash-butt welding machine that has a base and a platen slidably mounted on the base. A toggle connects the base and platen and means are provided for applying a large moving force quickly to the platen as the toggle approaches a straightened condition for effecting the upsetting of a work piece held by the platen.

2,435,504—Welding Rod—David L. Mathias, inventor, East Orange, N. J., assignor to Metal & Thermit Corp., New York, N. Y. (4 Claims)

In this patent, a weld rod coating, which is free from hydrous materials, is provided. The coating comprises fluorspar, calcium carbonate and ferrotitanium.

2,435,577—Spot-Welding Mechanism—John W. Dawson, inventor West Newton, Mass., assignor to Raytheon Mfg. Co., Newton, Mass. (15 Claims)

The patented welding machine has a fixed electrode and a movable electrode with the movable electrode being adapted to be brought into contact with the work. A previously fixed force is applied to the movable electrode after it contacts the work, and means limit the application of the fixed force to predetermine the pressure exerted upon the work.

2,435,702—Pressure Welding Machine—Phillip W. Vallee, inventor Lakewood, Ohio, assignor to Thompson Products, Inc. (4 Claims)

A special type of a power press is disclosed in the above patent. The press has cooperating work pressing platens which are relatively movable vertically. A horizontal arm extends between the platens and carries a torch ring, while a vertical track for the arm is positioned outside of the press between the platens. The arm and torch ring can be raised and lowered on the track to reciprocate the arm and ring between the platens and such movement can be varied to control the zone of reciprocation of the arm and torch ring with respect to one platen so that a jet discharged from the ring may be directed against the pieces to be welded on each side of the joint therebetween for such relative time intervals as will equally raise the temperatures of the pieces to be welded regardless of the composition and size of such pieces.

2,435,800—Automatic Welding Electrode—James M. Sawhill, Towson, and James E. Skinner, Dundalk, Md., inventors; assignors to The Reid-Avery Co., Dundalk, Md. (5 Claims)

This novel electrode is in the form of a stranded cable, the individual wires of which are disposed as helices and have flux cores.

2,435,815—Welding Apparatus—Merrill W. Ambrose, inventor, Roxbury, Mass. (8 Claims)

The welding device of this patent has a sleeve-like body with a tube telescoping within one end thereof and a head shield attached to the outer end of the sleeve. An electric conductor is secured within the tube and means are located within the head shield for holding a welding nail. A contact is disposed axially within the head shield and the conductor has a contact member that engages with the first said contact when the tube and sleeve are telescoped together.

2,435,852—Flux for Use in Arc Welding—Leonidas K. Stringham, inventor, University Heights, Ohio, assignor to The Lincoln Electric Co., Cleveland, Ohio. (2 Claims)

The patented flux contains specific percentages of the following materials: silica, lime, magnesium oxide, alumina, manganese oxide, ferrous oxide, carbon dioxide and Na_3AlF_6.

2,435,883—Wrought Gray Iron Welding Rod, Raymond J. Franklin, inventor, Chicago, Ill., assignor of one-third to Kermit B. Niles, Venice, and one-third to Howard D. Russell, Los Angeles, Cal. (4 Claims)

A welding rod made from wrought gray iron is broadly protected in this patent.

2,436,205—Resistance Welding Electrode—Le Roy Deitz and Ivar W. Johnson, inventors, Schenectady, N. Y., assignors to General Electric Co., a corporation of N. Y. (5 Claims)

The electrode of this patent consists of an intimate mixture of copper and carbon powders in which the percentage by weight of carbon present is about 1/4 to 3/4 per cent of the mixture.

Employment Service Bulletin

POSITION VACANT

V-218. Wanted. Gas welding sales engineer. Must be familiar with the gas welding process and the equipment. State education, experience and present salary.

THREE-DAY WELDING CLINIC AT MAY WHITEHEAD WELDING SHOW

A comprehensive Whitehead Welding Show will be held this year on May 13, 14 and 15 at the New York headquarters of Whitehead Metal Products Co., 303 W. 10th St., New York City. Feature of the show will be the presentation of the latest welding techniques of such leading names in the metal industry as: Aluminum Company of America, American Brass Co., International Nickel Co., Handy & Harman, A. O. Smith Corp., Mir-O-Col Alloy Co. and Lukens Steel Co.

Admission to the Welding Show is open to metal users, their representatives and employees, engineers and engineering students. Thursday and Friday, May 13 and 14 from 10 A.M. to 5 P.M., and Saturday, May 15, from 10 A.M. to 2 P.M. at the Whitehead New York headquarters.

America's FASTEST electrode-

...truly a "Hot Rod," the P&H DH-2 electrode cuts your production time and costs

You can profit by our experience: Vigorous competitive tests proved to us that the DH-2 rod deposits 1½ pounds more metal per hour than any other electrode in its 6020 class, and far more metal than electrodes of other classifications. In addition to its cost-lowering speed, DH-2 has these important features:

Good appearance — weld metal feathers out. Smooth, uniform bead greatly improves the looks of your fabricated products.

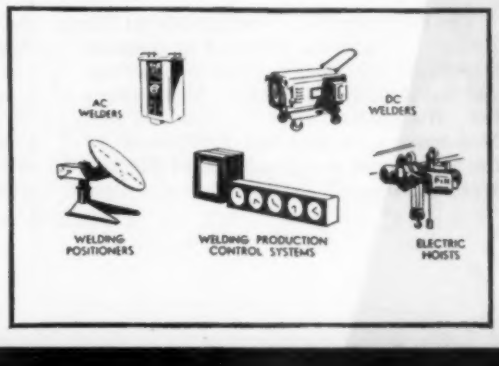
Your choice of medium or deep penetration — you can use normal welding amperages to produce medium penetration, and high amperages for the deep penetration essential for deep fillet technique.

Perfect X-ray quality — DH-2 is just the rod for heavy plate work where both high deposition rates and best weld metal are required.

Meets rigid requirements — DH-2 is approved by American Bureau of Shipping for conventional and deep fillet welds; U. S. Navy Bureau of Ships Grade II, Classes 2 and 3; Lloyd's Register of Shipping.

Easy slag removal and freedom from spatter — further enhance the high deposition speed of DH-2. You save production time and money all the way around with this highly efficient P&H electrode.

DH-2 is especially designed for down-hand position welding of mild and medium carbon steels. Use it on your horizontal, flat fillet, or groove welding and watch your costs drop. Order a supply now from your nearby P&H distributor or representative. And, write us today for latest bulletins giving pertinent details about America's most complete arc-welding service.



P&H

WELDING ELECTRODES

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HARNISCHFEGER CORPORATION

SECTION ACTIVITIES

ATLANTA

The January meeting of the Atlanta, Ga. Section was held on the 22nd. Walter J. Campbell, District Welding Specialist, General Electric Co., presented a GE sound, color film, entitled "Arc Welding at Work." Another film, "No Keener Blades," was shown through the courtesy of the Air Reduction Sales Co. Both films were well received. R. E. Lorentz, Jr., District Vice-President of District 3 (Southern) spoke on the AMERICAN WELDING SOCIETY, its purpose and benefits of membership.

An election of officers was to be held at this meeting. However, because of the small attendance, this was postponed and it was decided to continue with Mr. Campbell as Acting Chairman, Mr. Guillot as Acting Treasurer and Mr. Turner as Acting Secretary.

The February 16th meeting was held at Belmont Steak House. R. T. Gillette, General Electric Co., Schenectady, N. Y., presented a lecture and film on the subject of Resistance Welding.

BOSTON

A joint meeting with the Boston Section of the American Society of Mechanical Engineers was held on Tuesday, February 17th in the Graduate House, M. I. T., Cambridge. R. H. Davies of The Lincoln Electric Co., spoke on "Design of Weldments for the Machinery Industry." A film on "Design of Welded Machinery" was shown in conjunction with the paper. Both paper and film were well received.

BRIDGEPORT

The sixth meeting of the season of the Bridgeport Section was held on February 19th at The Consumers Institute of the General Electric Co. The meeting opened with an inspection trip through the resistance welding production line in the GE Bridgeport Works.

After the tour, F. L. Brandt of the Thomson Electric Co. presented an illustrated talk on resistance welding.

CINCINNATI

The regular meeting of the Cincinnati Section was held on Tuesday, February 24th, at the Engineering Society Headquarters. Norman G. Schreiner, Manager, Unionmelt Service and Development, spoke on the subject, "Construction and Maintenance of Railroad Equipment by the Submerged and Gas-Shielded Electric Welding Process." Following the regular meeting a very interesting film was shown, "Batting Stars of 1947 and 1947 World Series Games." "Dutch lunch" was served for all members and guests after the movie.

CLEVELAND

N. E. Wheeler, Welding Engineer of the Truck and Coach Division of General Motors Corp., Pontiac, Mich., spoke at the March 10th meeting on "Resistance Welding." In particular he discussed the setting up and controlling of spot welding machines in production through an interesting use of instrumentation.

A coffee talk was given by Mrs. Robert H. Browning, Chairman of the Speakers Bureau of the Cleveland Chapter, United World Federalists. She spoke on "Logic of Peace."

The February meeting was held on the 11th at The Cleveland Engineering Society. Dinner speaker was David Aitken, Industrial Development Engineer, Cleveland Electric Illuminating Co. Mr. Aitken spoke on the "Highlights of Cleveland's Industrial Development in 1947." A movie "Opportunity—The Story of the Best Location in the Nation" was also shown.

Technical speaker was A. N. Kugler, Mechanical Engineer, Air Reduction Sales Co., New York. Mr. Kugler spoke on "Brazing and Braze Welding." A film was also shown in connection with the talk on "No Keener Blade." This is an AIRCO film.

COLORADO

The February 10th dinner meeting was held in the Silver Wing Inn, Denver. A very interesting talk was presented by W. C. McLott, President of Resitso-Lay Co. of Grand Rapids, Mich. Mr. McLott spoke on "Hardfacings—Selections and Uses." A film "Golden Horizons" was shown through the courtesy of Ampco Metals, Inc.

COLUMBUS

R. W. Clark of the General Electric Co. was the guest speaker at the March 12th meeting. Mr. Clark spoke on the subject Welded Power Piping. His talk was of general interest covering the installation of power piping for steam turbine installations with some discussion of welding involved. Slides illustrated the talk.

The Section reports that its February Jeffry Plant visitation was a fine success with over 100 in attendance.

DAYTON

The February 25th meeting held at the Engineers Club was addressed by Norman G. Schreiner, Manager, Unionmelt Service and Development, The Linde Air Products Co. His subject was "Construction and Maintenance of Railroad Equipment by the Submerged and Gas-Shielded Electric Welding Process."

DETROIT

The Detroit Section again had the privilege and pleasure of being host to visiting members, from out of town for their Second Annual International Quiz the Experts program held on Friday, February 13th, in the beautiful auditorium of the Rackham Engineering Memorial Foundation Building.

Inclement weather of sleet, rain, high wind and flooded streets played havoc with the attendance. As a result only the most hardiest and enthusiastic of welding members were in attendance. But they made up in interest what they lacked in number and went away well rewarded for their special effort and time expended.

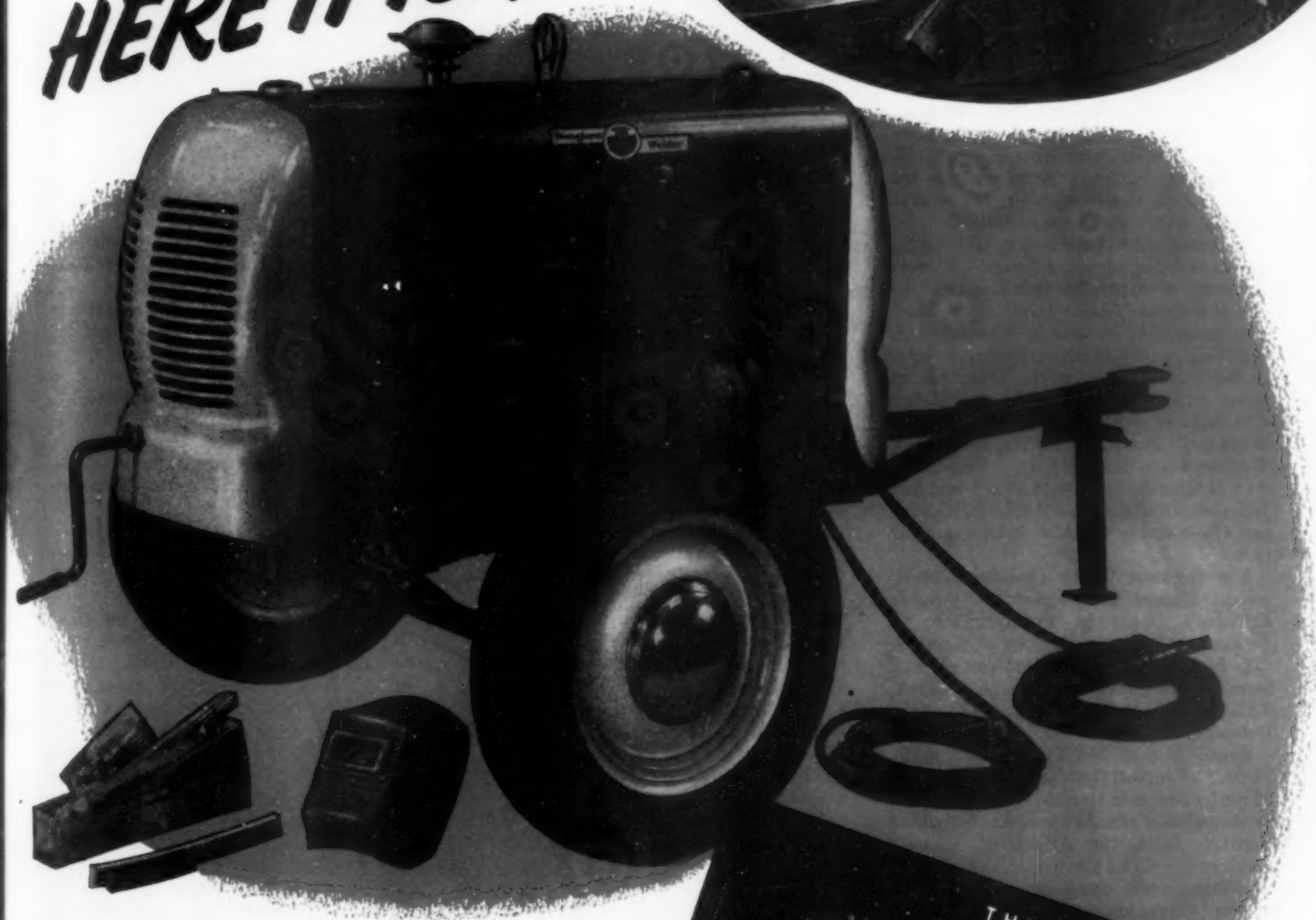
Dodge Truck assembly plant visitation during the afternoon preceded the evening program. Special mention and note should be made of the splendid cooperation and efforts of the Dodge Truck Plant master mechanic Joseph Phaunef and plant manager W. G. Finlel and their staff in personally conducting the guests through the various departments of the plant in such a manner as to leave them with a comprehensive picture of all the necessary functions in operating a modern truck assembly plant. Special emphasis was placed on the importance of welding in its many phases and high without it, they could not possibly manufacture truck components economically for trouble-free long-service life that Dodge trucks have established. An invitation was extended to the A.W.S. members to visit the Dodge plant again.

The Chairman introduced to the 143 members and guests the judges and competing teams as follows.

Judges: C. E. Jackson, Research Metallurgist, Union Carbide and Carbon Res. Lab., Niagara Falls, N. Y., Chairman of the Western N. Y. Section, A.W.S.; D. Night, Chief Eng., National Electric Welding Machine Co.

Competing Sections: Toronto Section, Canadian Welding Society—H. V. Nichols, Captain, Bureau of Mines, Ottawa, Ontario; Sidney Smith, Canadian Liquid Air Co., Toronto; W. A. Amos, Ferranti Electric, Ltd., Mt. Dennis, Ontario; Charles Eldridge, Canadian Kellogg Co., Toronto. Milwaukee Section—John J. Chyle, Captain, Director of Welding Research, A. O. Smith Corp.; Erwin Brekelbaum, Ex. Ch. Engr., Harnischfeger Corp.; Jerome B. Welch, Welding Engr., Cutler-Hammer Co.; Frank G. Flocke, Welding Engr., Trent Tube Co., E. Troy, Wis. Chicago Section—Eric R. Seabloom, Captain, Supervising Engr., Res. Lab., The Crane Co.; Robert L. Kohlbry, Vice-Pres., Machinery and Welder Corp.; Conrad L. Pfeiffer, Welding Engr., Consultant; Harris A. Goodwin, District Sales Mgr., Bastian-Blessing Co. Detroit

They asked for it... HERE IT IS!



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FLEXARC RANGER
ENGINE-DRIVEN WELDER

- LIGHT WEIGHT
- QUICKLY, EASILY MOVED
- STEPLESS CURRENT ADJUSTMENT
- RUGGED CONSTRUCTION
- WELDS ANYWHERE—ANYTIME

The men who supervise construction in hard-to-get-at spots asked for it . . . and wrote the specifications for it. Westinghouse produced it—a rugged, lightweight welder for rugged terrain. One that can go to work anywhere, any time . . . where electric power is not easily available.

The new Westinghouse engine-driven welder on wheels is smaller, lighter, but with big-welder stamina. Powered by a four-cylinder, 1800 rpm, Hercules industrial engine, the Ranger is designed and built to NEMA standards . . . has a rating of 200 amps, 30 volts, 50% duty cycle, with welding current range of 20 to 250 amperes. This wide range of welding current adjustment is divided over four overlapping ranges, in each of which stepless current adjustment is obtained by rheostatic control.

Easily transportable on 2-wheel, spring-mounted pneumatic-tired, standard road gauge running gear for road towing *at high speed*. Also available without running gear for stationary mounting.

Here's the welder you've been asking for—built for hard, continuous use on any kind of job. Welder comes complete, with all essential accessories, for immediate welding service. For full details, write Westinghouse Electric Corporation, P. O. Box 2025, Buffalo 5, N. Y.

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WELDERS AND ELECTRODES

Section—John Randall, Director Welding Research, Ford Motor Co.; George Martin, Rep., Federal Machine & Welder Co.; J. R. Stitt, Res. Engr., R. C. Mahon Co.; Robert Bennewitz, Dist. Engr., The Linde Air Products Co. T. J. Crawford, acting as moderator, gave each team a question in rotation, on one of the various phases of welding. All questions used on the program were received from members of the Detroit Section for this purpose. Judges Jackson and Knight awarded points according to the correctness and completeness of the answers given, and, of course, the decision of the judges was final.

In a thrilling see-saw battle, which saw the lead change hands several times, the Chicago Section came from behind to win the trophy. Captain Seabloom was presented with the trophy, an arc welding helmet, which had been metalized.

Ramsey Moon, Internation Welding Engineer and Consultant of Toronto, Canada, formerly of Australia and England, was one of the out-of-town guests. Mr. Moon was persuaded to give a short, but interesting account of his welding experiences in Australia and England. Other out-of-town guests were: Harold E. Bailey, Chairman of Milwaukee Section, A.W.S., William C. Pearson, Welding Sales Engr., Westinghouse Electric Corp., Vice-Chairman of Chicago Section, A.W.S.; and Ted Jefferson, Editor of *The Welding Engineer*, and Chairman of the A.W.S. Chicago Section.

The Saginaw Valley Division held its second Dinner Meeting of the year at Zehnder's Hotel in Frankenmuth on February 12th. Sparked by a membership increase of 34, the total number of members and guests in attendance was 102. This included Al Last and Ray Stitt of the Detroit Section.

Sound Movies of "The Louis-Wolcott Fight," "Football Highlights of 1947" and "Trout Fishing in Canada" were followed by the evening's feature program—"School Night." With Jim Alcock of Saginaw Welding Supply as Chairman, and a board of distinguished members as judges, a rousing discussion period followed each question. To keep everyone on his toes, the group was divided into two sections. Questions covering arc, gas and resistance welding were alternately asked of each section. Failure of any section to answer its question within two minutes referred that question to the other section. Needless to say, "School" was out all too soon.

HARTFORD

The Hartford Section has planned a joint meeting of all the New England Sections of the A.W.S. to be held in Hartford, Conn., on April 15, 1948. The program for the day will be as follows:

At 2:00 P.M. there will be a conducted tour through the Pratt Whitney Engine Division of United Aircraft. (In order to make this tour it will be necessary to bring along birth certificate.)

At 6:45 P.M. dinner will be served at the Bond Hotel. Principal speaker will be W. C. Beekley, President of Whitlock Mfg. Co.; also H. O. Hill, President of the A.W.S., and George M. Trefts III, District Vice-President of District 1, New York and New England. The trip through the aircraft factory, and the distinguished speakers, should stimulate a great deal of interest.

Dinner meeting was held on Thursday, February 19th, in the Whitlock Manufacturing Co. Cafeteria, Elmwood, Conn. This was "Amateur Night" and a good time was had by all.

INDIANA

The February dinner meeting of this Section was held on the 27th at Buckley's, Cumberland, Ind. W. P. Good, Welding Consultant, Mid-States Equipment Corp., Chicago, spoke on the subject, "High Frequency Gas-Shielded Arc Welding Processes."

LEHIGH VALLEY

L. W. Williams, Welding Engineer, Lukens Steel Co., Coatesville, Pa., was the guest speaker at the monthly meeting of the Lehigh Valley Section which was held Monday, March 1st, at the Hotel Bethlehem, Bethlehem, Pa. C. L. Kreidler, Vice-Chairman, presided at the meeting.

Mr. Williams spoke on "Welding of Clad Steels." He described in detail the process of forming clad steels, and told of the various techniques used in the cutting and welding of these steels. His talk was illustrated with films and slides. A discussion period followed the speaker's remarks.

A dinner meeting preceded the technical session, at which time a color film entitled, "A.-C. Welding" was shown through the courtesy of the Westinghouse Electric Corp. The film proved to be very interesting, pointing out the advantages of A.-C. welding.

The following is the program for the remainder of the season.

May 3rd—Annual Meeting and Ladies Night to be held at the Hotel Bethlehem, Bethlehem, Pa.

May 22nd—Through the courtesy of Air Reduction Sales Co., members and guests of the Lehigh Valley Section will visit the Air Reduction Laboratory at Murray Hill, N. J.

LOUISVILLE

Edgar B. Brown, Development Engineer, Detroit Branch, The American Brass Co., spoke at the dinner meeting in the Seelbach Hotel on February 24th. His subject was "Modern Practice for Welding Copper." Mr. Brown discussed the difficulties that had been experienced with a zone of porosity in the welding of copper and how this porosity could be eliminated by use of a gas atmosphere to control humidity. He also went into some detail in connection with the welding of silicon, phosphor and manganese bronzes. A discussion period followed the talk. Prior to Mr. Brown's talk, reports were heard from several committee chairman.

MARYLAND

The February meeting of the Maryland Section was held in the Engineers Club of Baltimore on February 20th. The technical program for this meeting included a motion picture on "Arc Welding" furnished by the General Electric Co. The technical speaker was R. N. Walters, Process Service Representative, The Linde Air Products Co., who presented a paper on "The Use of Gases in Modern Welding Processes." R. Karey of the Aeromatic Propeller Dept., Koppers Co., was also on hand to give a short talk on the welded propeller hub featured in the first main award paper of the Lincoln Design-for-Progress Contest. A very interesting display of semi-finished and finished propeller hubs was also furnished by the Koppers Co.

MICHIGAN

The Michiana Section held their February meeting on the 20th at the Bendix Legion Hall in South Bend. The meeting opened with a movie on the popular subject of fishing, and was followed by a talk on "Low-Temperature Silver Alloy Brazing" by Matt Wigton, Consulting Engineer, Silver Brazing Division, Goldsmith Bros. Smelting & Refining Co. Mr. Wigton described the methods of making the alloy and drawing it into wire, then mention some of the applications for this type of joining.

NEW JERSEY

The regular monthly dinner meeting of the New Jersey Section for February was held on the 17th at Essex House, Newark, N. J. A film was shown through the courtesy of the General Motors Corp. on "How Not to Conduct a Meeting."

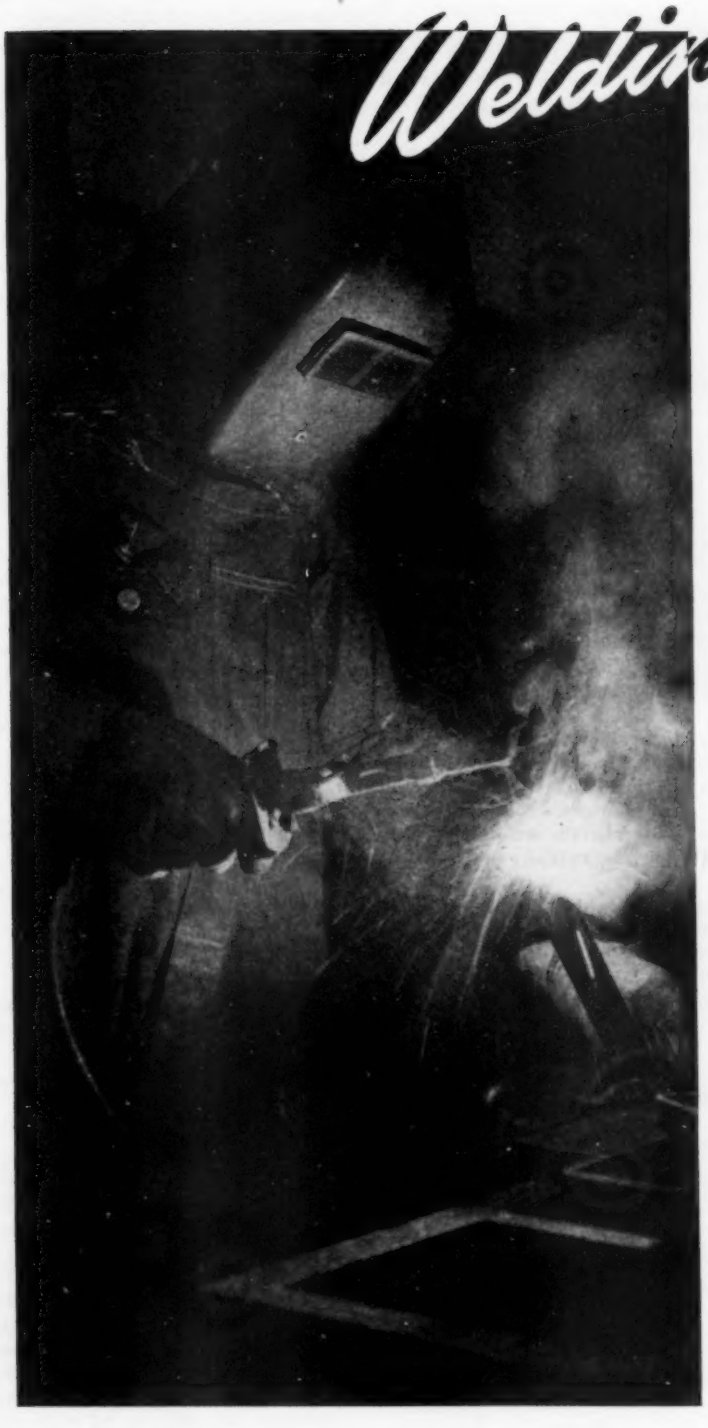
Speaker of the evening was Roger W. Clark, Welding Engineer, Welding Section, Schenectady Works Lab., General Electric Co., Schenectady N. Y. Mr. Clark's subject was "Welding Power Piping." This was illustrated with lantern slides and covered general problems in connection with the installation of power piping for steam turbines. Mr. Clark discussed the many welding problems involved. Mr. Clark explained many developments that are in the forefront of pioneering work in the power field.

NEW YORK

The New York Section held its annual joint meeting with the Metropolitan Section of the Society of Naval Architects and Marine Engineers on Friday, February 27th. The meeting was held at the Columbia University Club and was preceded by a buffet dinner at the Club. Over 150 people attended the dinner and nearly 250 turned out for the meeting.

Under the subject of "General Fabrication of Aluminum Alloys for Shipbuilding Purposes" B. J. Fletcher of the Aluminum Co. of America, described the alloys that are suitable for marine purposes and showed slides of many applications of these alloys. He spoke of the physical properties and the results of corrosion tests. He also covered the matter of surface protection and riveting practices.

PAGE *Welding* ELECTRODES



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G. O. Hoglund, also of the Aluminum Co. of America, spoke of the welding of these aluminum alloys with particular emphasis on the inert gas-shielded arc welding process. He expressed the belief that this process would greatly broaden the use of aluminum for marine purposes. The talk was followed by a motion picture "This is Aluminum" and the meeting was then thrown open for discussion. Although the members were still anxious to ask questions it was necessary to call a halt at 10 o'clock for the benefit of the commuters.

Arrangements for the meeting were in charge of M. J. Giraldi who is a member of both organizations. E. P. Trask, Chairman of the Metropolitan Section of the S.N.A.M.E., opened the meeting and H. R. Morrison, Chairman of the New York Section, A.W.S., served as Technical Chairman.

NORTHERN NEW YORK

The February 26th meeting of the Northern New York Section was held at Holland Inn, Schenectady. An interesting and enjoyable talk was given by William J. Farrell, Assistant to the Vice-President, Sciaky Bros., Chicago, on the subject of "Three-Phase Balanced Load Resistance Welding Machines." Mr. Farrell's talk, which was illustrated by slides, explained how Sciaky developed a resistance welding machine which converts three-phase power to single-phase power of lower frequency, resulting in a decreased kva demand and an approximately balanced three-phase load on the power distribution system.

This meeting which was preceded by dinner was attended by more than 30 members and guests of the Northern New York Section.

NORTHWEST

The sixth meeting of the 1947–48 season was held on Monday, February 9th, in the Lodge Room of the Covered Wagon. "Happy Half Hour" preceded the dinner. The speaker of the evening was Frank McGuire, Jr., Engineer of The Linde Air Products Co., Chicago, who spoke on the subject "Heliarc Welding." Mr. McGuire in his talk covered the basic principles involved and the primary fields of usage, as well as a description of many practical applications on aluminum, stainless steel and Everdur fabrication.

OKLAHOMA CITY

Regular Section meeting was held on Wednesday, March 3rd, at the Biltmore Hotel. John F. Randall of the Ford Motor Co. spoke on the subject "Effects of Hydrogen in Arc Welding." A very representative cross section of Oklahoma City industry was present and was very well pleased with the excellent manner of presentation and the fresh information Mr. Randall supplied. Since there was a relatively large percentage of shop men present, Mr. Randall kept his talk, as far as possible, in nontechnical terms.

PASCAGOULA

J. G. Magrath, Executive Secretary of the A.W.S., was the dinner speaker at the February 18th meeting held at the Pascagoula Country Club, Pascagoula, Miss. Mr. Magrath presented an excellent talk on the AMERICAN WELDING SOCIETY. The technical speaker was R. T. Gillette of the General Electric Co.'s Schenectady Works Laboratory. Mr. Gillette's subject was "Resistance Welding." A film on "This is Resistance Welding" was shown in conjunction with Mr. Gillette's talk. Both talk and film were enjoyed by all.

PEORIA

The February 18th meeting was held in Jefferson Hotel. J. R. Morrill, Assistant to the Vice-President of The Lincoln Electric Co., presented an illustrated talk on "Exposing the Hidden Arc." Mr. Morrill gave a very clear-cut presentation of automatic submerged arc welding and of the newly developed Manual submerged arc process.

PHILADELPHIA

A Panel Discussion was held on Friday, February 6th in the Junior Board Room of the Engineers Club. The subject was "Automatic Welding." Walter Mehl of Heintz Mfg. Co. was the meeting coordinator.

A forum type meeting was held on Friday, March 5th, sponsored by the Special Activities Committee of the Philadelphia Section. "Resistance Welding of Steel Containers" covered the making of steel cans, pails, barrels, cylinders, boxes and tanks.

The regular monthly meeting was held on Monday, February 16th, at the Engineers Club. W. B. Bunn, Welding Engineer, M. W. Kellogg Co., Jersey City, N. J., spoke on the subject of "Welding of Pressure Vessels."

PITTSBURGH

The regular monthly dinner meeting of the Pittsburgh Section was held on Wednesday, February 18th, at Mellon Institute. Dinner was held in the Hotel Webster Hall. F. A. Bodenheim, Jr., Sales Engineering Manager, Federal Machine and Welder Co., Warren, Ohio, discussed the general principles and types of resistance welding, covering spot, seam, flash and projection welding, as well as, where and when it can be applied. A color sound movie "This is Resistance Welding" was also shown.

Plans are under way for the Eleventh Annual Tri-State Convention to be held Friday Afternoon and Evening, April 30th: afternoon—Technical Session; evening—Ladies Night. Dinner, door prizes, music and dancing.

PUGET SOUND

The February meeting of the Puget Sound Section took place on Wednesday, February 11th, at the Engineers Club in Seattle. The speaker was John W. Dickinson, Service Supervisor for The Linde Air Products Co. in this district. His subject was Inert Gas-Shielded Arc Welding.

In this timely topic, he discussed the relative advantages of using argon and helium gases for different types of metals and the different applications where either d-c motor generator arc welders or high-frequency alternating-current arc welders would be preferred. The importance of various types of joints and back-up bar combinations were also stressed.

Altogether, it was a very informative evening, and the members received a lot of practical tips in this new field of welding.

ROCHESTER

The March 4th dinner meeting was held at the University of Rochester. Speaker was F. L. Brandt of the Thomson Electric Welder Co., whose subject was, "Modern Trends in Resistance Welding." A movie "This Is Resistance Welding" was shown through the courtesy of the General Electric Co.

The Section is conducting an educational program of practical and instructive demonstrations and discussions. Nonmembers are invited. These take place at the Engineering Building, University of Rochester, 7:45 P.M. except the April 15th meeting which will be held at the Pfaudler Co. The remainder of the educational meetings are as follows:

April 15—Automatic Welding (at the Pfaudler Co.).

April 29—Automatic Hydrogen Welding.

May 15—Weldability.

SAN FRANCISCO

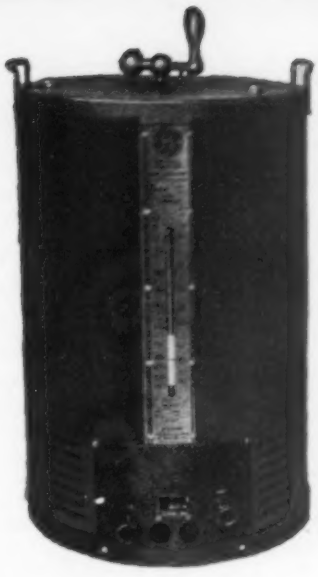
A plant visitation to the Western Pipe and Steel Company was held on Wednesday, February 25th.

SOUTH TEXAS

Dinner meeting was held on February 6th at the University of Houston. Guest speaker was Dr. W. G. Theisinger, Manager of Technical Plate Sales, Lukens Steel Co., who spoke on Clad Steels and Economical Selection of Materials for Fabrication. Dr. Theisinger's lecture was an exceptionally interesting and instructive discussion of the subject. Pertinent information relative to fabrication of clad materials was illustrated with slides and fundamentals of good practice in rolling and welding clad sections were discussed by the speaker. Motion picture "Production of Clad Steels" illustrated the technique of combining the clad material with the carbon steel base, and pointed out some of the difficulties encountered therein.

The Secretary reported highly successful results in connection with a short course in welding conducted January 19–21, inclusive. Lectures were conducted by R. H. Davies of The Lincoln Electric Co.

A-C WELDERS



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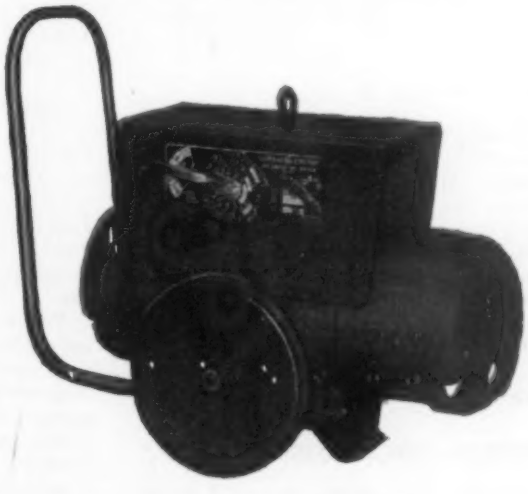
D-C WELDERS



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ELECTRODES AND ACCESSORIES—63 types of G-E welding electrodes can help provide the answer for welding mild steel, cast iron, stainless steel, phosphor bronze—general-purpose welding, and alloy and special-purpose welding. G-E welding accessories, described in catalog GEA-2704, are designed for easier welding with maximum protection.

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SYRACUSE

John D. Gordon, General Manager of the Progressive Welder Co. of Detroit Mich., was the guest speaker at the March 10th meeting held in the Hotel Syracuse.

Mr. Gordon is one of the most widely known executives in resistance welding being a past director or the Resistance Welder Manufacturers' Association. His talk covered new developments in Resistance Welding power supply using slides for illustrations.

Technical Chairman A. M. D. Cassel of Smith & Caffrey Co. gave a short talk on the use of manual submerged arc-welding equipment.

The meeting was opened with a series of sports films and followed by refreshments sponsored by the Fitzgibbons Boiler Co. of Oswego, N. Y.

The April 14th meeting will feature Norman G. Schreiner of The Linde Air Products Co., speaking on "Shielded Electric Welding in Railroad Construction and Maintenance" covering both submerged arc and gas-shielded welding processes.

WASHINGTON, D. C.

February 24th meeting was held in Wearley's Sea Food Restaurant. J. R. Hunter, Manager, Welding Section, Research Dept., Revere Copper and Brass, Inc., spoke on "The Welding of Copper Brass Alloys." Mr. Hunter is an expert on the subject of welding copper and the author of the most recent book on the subject *Welding Copper*.

District Vice-President Harry W. Pierce visited the Section, attended dinner and addressed the group.

WESTERN MASSACHUSETTS

January 19th meeting was held in the Hotel Sheraton, Springfield, Mass. This was a joint meeting with the Springfield Chapter of the American Society for Metals. A. R. Lytle, Research Engineer, Union Carbide and Carbon Corp., Niagara Falls, N. Y., spoke on the "Weldability of Steels."

Coffee speaker was R. A. Lambert, Industrial Designer, Westinghouse Electric Corp., East Springfield Plant. Mr. Lambert spoke on "Lines and Colors in Relation to Appearance of Machines and Appliances."

The February 18th meeting was held at the Westinghouse Electric Corp., East Springfield, Mass. A "Resistance Welding Forum" was presented by a group of staff employees of the Westinghouse Corp. A film "Resistance Welding" was shown; as well as a display of work performed at Westinghouse.

WESTERN MICHIGAN

The fifth regular meeting of the Western Michigan Section was held on January 26th at the Association of Commerce Cafeteria in Grand Rapids. Dinner speaker for the evening was R. H. Newton, member of the national A.W.S. Membership Committee who outlined a very interesting program for increasing membership in Sections.

Technical speaker on the program was Leon C. Bibber, Welding Engineer for Carnegie-Illinois Steel Corp. In his interesting illustrated subject, "The Elements of Welded Design," Mr. Bibber emphasized the need for better design for welded products, the elimination of "draftsmen's dreams" in our design and the effectiveness of welding as an economical tool of construction when correct design principles are applied. A lively discussion by the record audience of 105 members and guests followed the presentation.

The meeting adjourned after the showing of the film "U.S.S. Cor-Ten."

Attendance and membership in the Western Michigan Section has been on the upswing for the first half of the 1947–48 season by the promotion of more intense publicity, improvement in program arrangements of a wide variety and technical services from national headquarters.

WORCESTER

The February 23rd meeting was held in the Svea Gille Club, Shrewsbury, Mass. Speaker was L. M. Klentz, who spoke on "Resistance Welding Applications." Discussion was held by R. K. Waldvogel of the Pullman Standard Car Manufacturing Co.

YORK-CENTRAL PA.

C. C. Keyser, Welding Engineer, Bethlehem Steel Co., Steelton, Pa., was the guest speaker at the March 3rd meeting held in the Engineering Building, York, Pa. Mr. Keyser spoke on the subject "Maintenance Welding in the Steel Mill."

CANADIAN WELDING SOCIETY

February 16th meeting of the Montreal Chapter was held at the Barkeley Hotel, Cartier Room. LaMotte Grover, Welding Engineer, Air Reduction Sales Co., New York, spoke on "Design, Fabrication and Erection of Welded Steel Structures."

March 1st meeting of the Toronto Chapter was held at Malloneys Art Gallery. Speaker was D. C. Smith, Chief Metallurgist, Electrode Division, Harnischfeger Corp., Milwaukee, Wis., who spoke on "Arc Welding Electrode Coatings and Their Effect Upon Welding."

March 2nd meeting of the Hamilton Chapter was held at McMaster University. Speaker was R. J. Anderson, Manager, Unionmelt and Heliarc Service, Dominion Oxygen Co. Ltd., Toronto, Ontario, who spoke on "Heliarc Welding of Corrosion Resisting Metals."

March 3rd meeting of the Kitchener-Waterloo Chapter was held at Babcock-Wilcox & Goldie-McCulloch Ltd. The meeting consisted of a conducted tour of the North Plant, and later a film entitled "Steam" depicting boiler manufacture in their plant in Scotland was shown at the South Plant.

March 10th meeting of the Niagara District Chapter was held at St. Catharines Collegiate. "Heliarc Welding of Corrosion Resisting Metals" was presented by R. J., Anderson, Manager, Unionmelt and Heliarc Service, Dominion Oxygen Co. Ltd. Toronto.

March 15th meeting of the Montreal Chapter was held at the Berkeley Hotel, Carrier Room. This was known as "Local Boys' Night."

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